

ANNALS OF SURGERY

VOL. LIV

DECEMBER, 1911

No. 6

ORIGINAL MEMOIRS.

THE VALUE OF THE LEUCOCYTE COUNT IN ACUTE SURGICAL DISEASES.

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WITHIN the last decade leucocyte counting in acute surgical diseases has acquired a new meaning, due largely to the recognition of the value of the differential count. For many years total counts only were made, and these yielded but little information, as their significance was not well understood. An ordinary furuncle might produce a high count, while a severe general peritonitis might reveal a leucopænia, and these facts could not be satisfactorily explained. Since a more complete blood picture has been utilized in the study of this class of diseases, valuable information as to the diagnosis and prognosis has been made available. The limitations of all laboratory work, however, must be recognized. The laboratory alone cannot, save in exceptional instances, make a diagnosis for the physician. The clinical findings must be correlated with those from the laboratory, and this is especially true of blood work in acute surgical diseases. It is necessary to carefully exclude all other conditions which might cause a departure from the normal.

For the purpose of this paper it is essential to have, as a working basis, an average normal, not only of the total number of white cells, but also of the polymorphonuclear cells.

As the polymorphonuclear cells are principally affected in inflammatory diseases, they alone of the various types will be considered. Various writers give the average number of leucocytes considered normal from 6000 to 10,000, and the average normal percentage of polymorphonuclears from 60 to 80 as follows:

Sondern	6,700	68 per cent.
Von Limbeck	8,500	70-80 per cent.
Da Costa	7,500	60-75 per cent.
Gibson	10,000	75 per cent.
Hayem	6,000	
Tumas	6,200	
Graeber-Reineke	7,242	
Boeckner-Halla	7,533	
Thoma	8,687	

If 10,000 is taken as the maximum number for the total count and 75 per cent. as the highest percentage for polymorphonuclears, the average normal will probably not be too low. The total count of itself is of little value, as it is influenced by many factors. These may be classified as follows:

A. Physiological leucocytosis: (1) leucocytosis of new born; (2) leucocytosis of digestion; (3) leucocytosis of pregnancy; (4) leucocytosis after parturition; (5) leucocytosis of violent exercise; (6) leucocytosis of cold baths and massage; (7) terminal leucocytosis.

B. Pathological leucocytosis: (1) post-hemorrhagic; (2) inflammatory; (3) toxic; (4) malignant disease; (5) due to therapeutic and experimental influences.

Then, too, in severe infections which are poorly resisted, a low total count is frequently observed; while in mild infections well borne, a high total count may be found.

The differential count, on the other hand, is of much greater value, since this is, as a rule, uninfluenced by physiological factors, and the changes due to the pathological conditions are more definitely defined. When both total and differential counts are taken and the relation each bears to the other is considered, the assistance rendered in the diagnosis and prognosis of the disease in question possesses a value

vastly greater than either of the less complete and unrelated observations.

Surgery deals with general rules, and not with absolutisms, and there are exceptions to nearly all rules. The following statements, however, may be considered as general rules:

1. The total count is an index of the patient's resistance to the infecting organism.

2. The relative polymorphonuclear count is an index of the degree of, or the severity of, the infection.

3. If we have a relative polymorphonuclear count ranging between 75 per cent. and 80 per cent., infection is probable; if between 80 per cent. and 85 per cent, infection is usually found; if above 85 per cent., infection is almost invariably encountered, and this regardless of the total number of leucocytes. In fact, some laboratory workers do not make use of the total count at all, but depend for diagnosis entirely upon the differential count.

A few points can usually be decided by reference to both counts, namely:

(a) bodily resistance, whether high or low; (b) infection, whether severe or mild; (c) infection whether well borne or poorly resisted; (d) infection, whether circumscribed or un-circumscribed (*e.g.*, appendiceal abscess).

Gibson¹, of New York City, speaks of the relative disproportion between the differential and total counts, and considers that "bodily resistance is more clearly defined by this disproportion than by any other means at our command, and that of all methods of blood examination, this is the most valuable, both from a stand-point of diagnosis and prognosis."

Dr. Gibson has suggested the use of the chart in order to more clearly show this disproportion. He assumes 10,000 as the maximum normal for the total number of leucocytes and 75 per cent. as the highest percentage of polymorphonuclear cells to be considered normal. He further assumes that, "In inflammatory lesions which are well borne, the

¹ The Value of the Differential Count in Acute Surgical Diseases, ANNALS OF SURGERY, 1906, pg. 485.

polymorphonuclear cells are increased 1 per cent. above 75 per cent. for every 1000 of the total leucocytes above 10,000." Upon this basis he has made some interesting observations.

Chart I shows a typical Gibson chart.

CHART I.

35,000	.....	100
30,000	.....	95
25,000	.....	90
20,000	.....	85
15,000	.....	80
10,000	.....	75

An infection which is well resisted will show a parallel line, or else a line the obliquity of which will run toward the leucocyte side of the chart (see Chart II.) If the line runs about level, whether high or low, it indicates that a lesion, whether severe or not, is well borne and therefore of good prognosis.

The obliquity of the lines determine the prognosis in a given case.

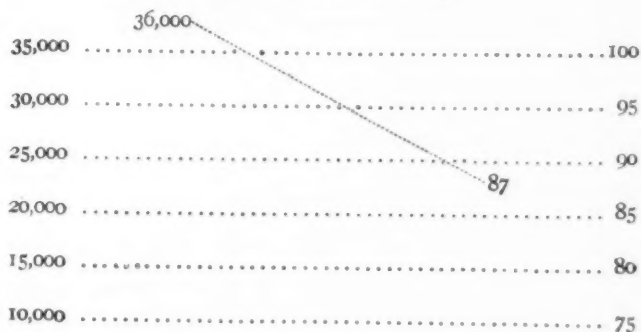
Chart II shows the count in a case of acute suppurative appendicitis placed upon the Gibson chart. In this case there is a slightly falling line, but it shows that the infection is well resisted. Patient recovered; infection, colon bacillus.

CHART II (Case No. 66).

35,000	.....	100
30,000	.....	95
25,000	.....	90
20,000	.....	85
17,200	.....	80
15,000	.....	80
10,000	.....	75

Chart III shows a case of pelvic abscess. We have here a favorable condition for operation, as the line runs from the leucocyte side downward with a marked degree of obliquity. Result, recovery, with no unfavorable symptoms.

CHART III (Case No. 80).



Gibson states that all of his fatal cases showed a rising line. In our series, four revealed a slight falling line. It is important in this connection to take into consideration, as suggested by Fowler,² the duration of the disease, because we know that where infection is severe resistance is in time overcome, and then our counts will be of little value.

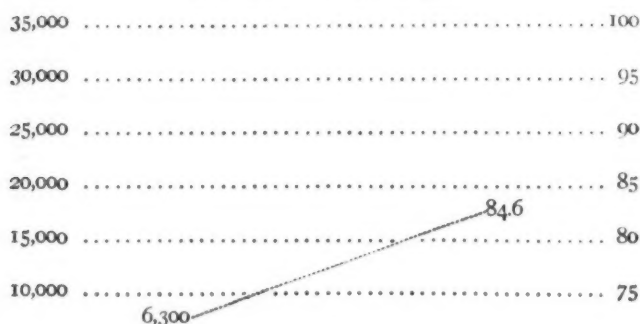
Chart IV shows a case of general peritonitis (diagnosis confirmed by autopsy). The very low total count and the marked deviation upward of the line toward the polymorphonuclear side of the chart make this a case where the prognosis is exceptionally unfavorable.

I wish to report 100 cases taken from Dr. Metcalf's and my own private records. The cases are all of the acute inflammatory type, and all have been brought either to operation or autopsy, so that the diagnosis has been either confirmed or disproven. In a number of cases many counts have been made, but the count made immediately before the operation has been the one used in this series. No one will deny that repeated counts are of much greater value in diagnosis than

² The Relation of Appendicitis to the Leucocyte Count, *Surgery, Gynecology and Obstetrics*, Sept., 1908.

one isolated count. This point is especially emphasized by Gibson: "The importance of a disproportionate increase of polymorphonuclear cells, particularly if progressive, cannot be overestimated, and those wilfully disregarding such evidence are perhaps not exhausting all resources available for diagnosis."

CHART IV (Case No. 42).



The cases may be classified as follows:

Acute catarrhal appendicitis.....	13
Acute suppurative appendicitis (circumscribed).....	10
Acute suppurative appendicitis (uncircumscribed).....	9
Acute perforative or gangrenous appendicitis	6
Acute pyosalpinx	12
Pelvic abscess	18
Puerperal sepsis	13
Pelvic lymphatic infection	3
General peritonitis	5
Acute cholecystitis	4
Stitch abscess	3
Abscess of kidney	1
Abscess of parotid gland	1
Subphrenic abscess	1
Infected ectopic gestation (ruptured).....	1
Total	100

The appendicitis cases are interesting, and we have come to depend on the leucocyte count as an important factor in the diagnosis and prognosis of this disease.

Thirteen catarrhal cases show:

Average total count..17,907	Average polymorphonuclear .83%
Highest total count..33,000	Highest polymorphonuclear .90%
Lowest total count... 8,900	Lowest polymorphonuclear .73%

Six cases of perforative and gangrenous:

Average total count..19,517	Average polymorphonuclear .89.16%
Highest total count..30,000	Highest polymorphonuclear .90%
Lowest total count...13,500	Lowest polymorphonuclear .83%

Nine cases of suppurative (uncircumscribed):

Average total count..18,051	Average polymorphonuclear .89.8%
Highest total count..27,700	Highest polymorphonuclear .98.6%
Lowest total count.. 5,900	Lowest polymorphonuclear .81%

Ten of circumscribed abscess:

Average total count..19,049	Average polymorphonuclear .86.75%
Highest total count..36,200	Highest polymorphonuclear .97%
Lowest total count... 9,100	Lowest polymorphonuclear .78%

Closely allied to this group are the cases of acute pyosalpinx, puerperal sepsis, and pelvic abscess.

Of pyosalpinx, there are twelve cases with the following data:

Average total count..15,133	Average polymorphonuclear .83.3%
Highest total count..31,660	Highest polymorphonuclear .89%
Lowest total count...6,300	Lowest polymorphonuclear .67%

Of puerperal sepsis, thirteen cases:

Average total count..16,315	Average polymorphonuclear .81.5%
Highest total count..26,200	Highest polymorphonuclear .98%
Lowest total count...12,300	Lowest polymorphonuclear .76%

Of pelvic abscess, eighteen cases:

Average total count..20,005	Average polymorphonuclear .83.3%
Highest total count..31,000	Highest polymorphonuclear .91%
Lowest total count...10,200	Lowest polymorphonuclear .70%

Four cases of cholecystitis show averages very high:

Average total count..20,055	Average polymorphonuclear .92.4%
Highest total count..33,920	Highest polymorphonuclear .97%
Lowest total count... 7,500	Lowest polymorphonuclear .90%

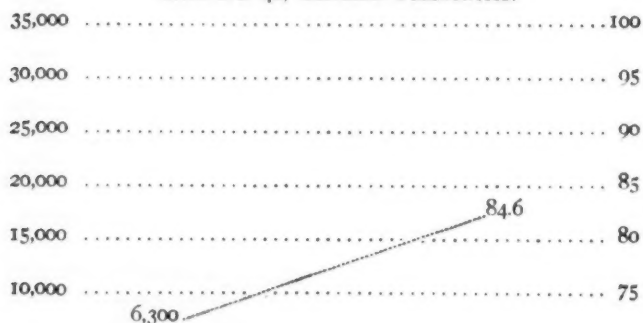
The case of acute suppurative cholecystitis (Chart V) is the only one in our series that revealed such a sharp (15°) rising line on the Gibson chart, and still recovered. This was a case of a woman over seventy years of age, who was operated upon within two days after symptoms appeared. This count indicates the low vitality of our patient, and an infection of marked severity.

CHART V (Case No. 22).



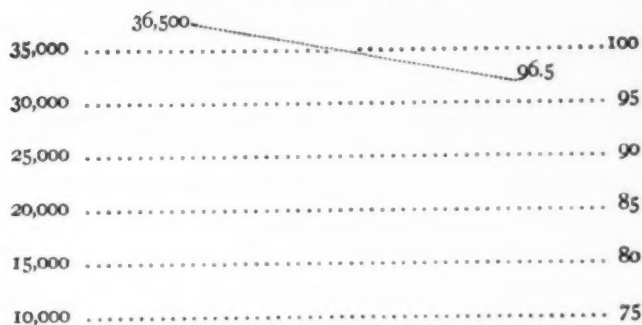
The five cases of general peritonitis all died, three showing a rising line and two a falling line, as shown in the accompanying charts.

CASE NO. 42, GENERAL PERITONITIS.



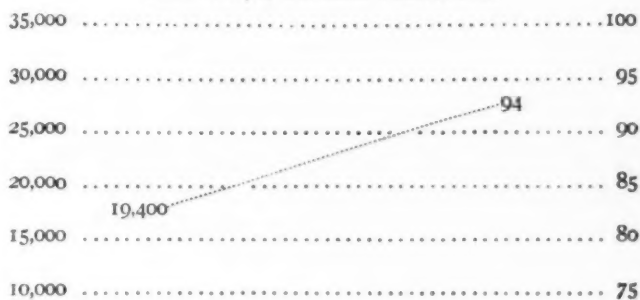
Three cases of stitch abscess are interesting to illustrate what a marked leucocytosis a small stitch abscess is capable of producing: Case 17, total count 16,200, polymorphonuclear 85.5 per cent.; Case 16, total count 25,000, polymorphonuclear 87 per

CASE No. 55, GENERAL PERITONITIS.



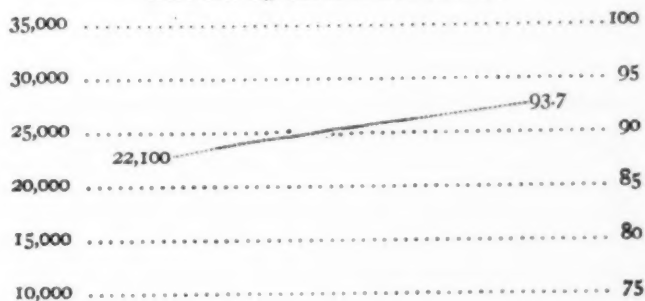
Fatal case, infection mixed, streptococcus predominating. Infection existing over short period of time only.

CASE No. 70, GENERAL PERITONITIS.



Fatal case.

CASE No. 84, GENERAL PERITONITIS.



Fatal case.

cent.; Case 100, total count 23,400, polymorphonuclear 93.5 per cent.

The remaining cases may be tabulated as follows:

Pelvic lymphatic infection, three cases: Case 82, total count 22,100, polymorphonuclear 91 per cent.; Case 49, total count 11,200, polymorphonuclear 81.5 per cent.; Case 34, total count 7,800, polymorphonuclear 75 per cent.

CASE NO. 89, GENERAL PERITONITIS.

35,000	100
30,000	95
25,000	90
20,000	85
19,500	
15,000	80
10,000	75

Fatal case. Long continued infection.

Ruptured ectopic gestation (infected), one case: Case 77, total count 22,000, polymorphonuclear 87 per cent.

Subphrenic abscess, one case: Case 96, total count 35,000, polymorphonuclear 79 per cent.

Abscess kidney, one case: Case 48, total count 35,890, polymorphonuclear 91.5 per cent.

Abscess of parotid gland, one case: Case 50, total count 12,200, polymorphonuclear 91 per cent.

Our averages when classified according to the polymorphonuclear count may be arranged in the following order:

	Total	Polymorphonuclear
Pelvic lymphatic infection	13,866	82.3 per cent.
Acute catarrhal appendicitis	17,907	83 per cent.
Pelvic abscess	20,005	83 per cent.
Acute pyosalpinx	14,636	83.3 per cent.
Appendiceal abscess (circumscribed)	19,089	85.75 per cent.
Appendiceal abscess (uncircumscribed)	18,175	86.4 per cent.
Puerperal sepsis	16,315	86.9 per cent.
Stitch abscess	21,733	87.6 per cent.

	Total	Polymorphonuclear
Gangrenous and perforative appendicitis	19,516	89.1 per cent.
General peritonitis	20,564	89.5 per cent.
Acute cholecystitis	20,055	92.3 per cent.

It seems to the writer that these averages are significant. Excluding the counts in stitch abscess and puerperal sepsis, the following points are noted. In acute inflammatory diseases in the pelvis the polymorphonuclear counts are low. When we approach the appendiceal region the count is higher, but when we reach the "attic" of the abdomen our records show very marked increase in both total and polymorphonuclear counts.

A question that arises at this time is: "Can we place the percentage of polymorphonuclear cells at a certain number below which we do not expect to find infection?"

Sondern³ has the following to say in this respect: "A relative percentage of polymorphonuclear cells below 70 with an inflammatory leucocytosis of any degree excludes the presence of pus or gangrene at the time the blood examination is made, and usually indicates good bodily resistance toward infection." Gibson cited three pus cases with polymorphonuclear counts below 70 per cent., and in my series I had one case (Case 27, acute pyosalpinx with adhesions and small pockets of pus among adhesions).

I do not believe that between 65 per cent. and 80 per cent. we can state with any degree of accuracy that the count *per se* means the presence of infection.

The writer believes that in acute inflammatory surgical diseases repeated counts at frequent intervals should be made, and if the polymorphonuclear percentage rises while the total number remains stationary or falls, immediate operation should be insisted upon.

In some cases we found that the leucocyte count did not help us in making a diagnosis, and in these cases we have dis-

³The Present Status of Blood Examinations, Medical Record, vol. lxvii, pp. 452-455.

regarded the blood findings entirely and depended upon the history and physical signs, but in cases where the count has been positive its value could not be easily underestimated.

Leucocyte counts are sometimes valuable for their negative findings, *e.g.*, they are frequently of assistance in making a diagnosis between a small ovarian cystoma with a twisted pedicle and a pyosalpinx or appendicitis. Dr. Metcalf operated upon a case illustrating this. A very large woman with thick abdominal wall was suddenly seized with pain over McBurney's point and vomited. Tension of muscle and tenderness were present in the right lower quadrant of abdomen. Temperature and pulse were normal. Vaginal examination revealed nothing positive. Diagnosis, small ovarian cyst with a twisted pedicle, right side, or acute appendicitis. Blood count revealed 8590 leucocytes with 62 per cent. polymorphonuclears. Diagnosis after blood count, ovarian cyst with twisted pedicle, and this was confirmed by laparotomy.

The counts enumerated in this paper were made by Drs. Safford, Torrey, and myself, and a uniform technic was followed.

I wish to acknowledge my indebtedness to Dr. Metcalf for the perusal of his case records, and to Drs. Safford and Torrey for assistance rendered.

CONCLUSIONS.

1. The laboratory findings must be correlated with the clinical to be of any value at all.
2. The total count alone is insufficient.
3. The differential count, *per se*, is of value in diagnosis, but of little value in prognosis.
4. The total and differential counts, when taken together and correlated with the clinical findings, are frequently of great value both in diagnosis and prognosis.
5. No definite percentage of polymorphonuclear cells can be taken to positively indicate infection. If we have a percentage of between 75 and 80 of polymorphonuclear cells,

infection is probable; if we have a percentage of between 80 and 85, infection is usually found; if we have a percentage above 85, infection is almost invariably encountered.

6. The negative value of the count is sometimes very useful in diagnosis.

7. The duration of the infection must be taken into consideration.

Counts are more positively diagnostic when taken early in the course of an acute surgical disease. Infection will frequently, when of long duration, overcome the patient's resistance and so vitiate the value of the count.

THE TRANSPLANTATION OF FREE FLAPS OF FASCIA.

AN EXPERIMENTAL STUDY

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INTRODUCTION.—For some time I have been interested in the methods brought forward for replacing and for reinforcing weakened or defective tissues, and while some of the methods are admirable, all are limited in their application. It seemed worth while to search for a material which would accomplish the same purpose but would have a wider field of usefulness.

In looking about for some suitable tissue in the body which was easily obtainable, which had considerable strength, and at the same time was sufficiently flexible for any desired need, I was led to try the experimental transplantation of free flaps of fascia.

After proceeding with the experiments for some time I found that some excellent work had already been done along this line.¹ However, my results were sufficiently suggestive to warrant a report on the subject, in order to again call attention to this promising surgical procedure.

¹Kirschner, M.: Ueber freie Sehnen-und Fascien. Transplantation, Beitr. z. klin. Chir., 1909, lxxv, 472.

Günther: Ueber Duraplastik: eine klinisch-experimentelle Studie, Beitr. z. klin. Chir., 1910, lxxix, 740.

Hohmeier: Ueber ein neues Verfahren zur Deckung von Trachealdefekten, München. med. Wchschr., 1911, Bd. lviii, 948.

Since this paper was handed in for publication the following experimental-clinical articles have appeared. They will be considered fully in another report.

Hohmeier, F: Experimente über Verschluss von Wunden und ueber-

Sixty-two experiments were done on 39 dogs. Ether anaesthesia was used in each experiment.

Technic.—The part was shaved, washed with green soap and water, then with alcohol and ether. After the skin was thoroughly dry it was painted with tincture of iodine 2.5 per cent. The iodine solution was also freely used in the open wounds and after suture of the skin.

Fine black silk was the ligature and suture material used throughout. The wounds were closed in layers wherever possible. The skin was closed in every instance with the button-hole stitch.

Dry sterile gauze secured by a bandage was used wherever dressings were applied.

The fascia was obtained, for the most part, from the thigh, the iliotibial band of the fascia lata being the most satisfactory portion to work with, as it is easily separated from the underlying tissues. In a few instances the strong abdominal fascia was employed.

The fascia was transplanted in both single and double layers and in one or two instances was twisted.

In each experiment where adhesions were not desired the fascia lata (iliotibial band) was placed with the inner or muscle surface exposed. For example, when a flap of fascia was placed in a peritoneal defect, the muscle or smooth side was turned toward the peritoneal cavity, and it was found that dense adhesions were less likely to occur than when the outer side was turned toward the cavity.

In this series, unless otherwise stated, the fascia was transplanted into the same animal from which it was taken.

An attempt was made to place free flaps of fascia on the various tissues, in order to test its vitality and obtain an idea of its possibilities for clinical use.

brückung von Defecten Schleimhauttragender Körpercanäle und-höhlen durch freie auto-plastic, Arch. f. klin. Chir., 1911, 345.

König, F.: Neue Wege der plastischen Chirurgie. (Verschluss und Ueberbrückung), Arch. f. klin. Chir., 1911, 326.

Lewis, D. and Davis, C. B.: Experimental Direct Transplantation of Tendon and Fascia, J. Amer. Med. Assn., lvii, 1911, 540.

Experiments.—For convenience I have divided the series into eight groups. To economize space I will only report a few of the typical experiments in each group.

Group I.—Transplantation of Free Fascia into Subcutaneous Tissue, on Fat; on Muscle; Periosteum, on Naked Bone; Cartilage, Tendons and Ligaments.

EXPERIMENT 6.—Male, black mongrel; about nine months old. *Operation*, November 22, 1910: A piece of fascia lata was sutured in the subcutaneous tissue of the chest wall. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

February 23: Distemper. The animal was sacrificed. *Autopsy.*—The fascia was somewhat thickened but otherwise it seemed normal. It was strong and tough.

*Histology.*²—Microscopic examination showed apparently normal fascia with fibres and nuclei clearly stained. No degeneration.

EXPERIMENT 7.—Female, white fox terrier; about six months old. *Operation*, November 28, 1910: The sartorius muscle was exposed and a broad band of fascia lata was sutured snugly around it. The wound was closed in the usual manner. No dressing. Condition on leaving the table excellent. *Per primam* healing.

January 16, 1911: Animal sacrificed. *Autopsy.*—The fascia was somewhat thickened but otherwise it seemed normal. The fascia band could be easily stripped from the muscle.

Histology.—Microscopic examination: the sections showed normal fascia with no signs of degeneration.

EXPERIMENT 8.—Female, tan mongrel; about six months old. November 29, 1910, a flap of fascia lata was removed from the thigh and wrapped in moist salt gauze and then placed in the ice box in a sterile jar.

Operation.—December 1, 1910: The fascia which was placed in the ice box forty-eight hours ago was sutured on the ribs, under the muscle. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

January 24, 1911: Animal sacrificed. *Autopsy.*—The fascia was thickened but otherwise it seemed normal. It was movable on the ribs.

Histology.—Microscopic examination: the sections showed normal fascia with clearly stained nuclei and fibres.

EXPERIMENT 9.—Male, black and white fox terrier; about two years old. *Operation*, December 1, 1910: The right femur was exposed and the periosteum was stripped back for about 2 cm. Into this defect a band of fascia lata was sutured around the bone. The wound was closed in the usual manner. No dressing. Condition on leaving the table excellent. *Per primam* healing.

² I take this opportunity of thanking Dr. C. D. Deming for assistance in the histological examinations.

December 27: Death from pneumonia. *Autopsy*.—The band of fascia was somewhat thickened and was intimately blended with the periosteum on either side. The structure of the fascia could be plainly seen.

Histology.—Microscopic examination: the sections showed normal fascia with no signs of degeneration.

EXPERIMENT 43.—Female, white mongrel; about two years old. *Operation*, March 14, 1911: The trachea was exposed and a large flap of fascia was sutured on it. This fascia had been removed from another animal on February 7, 1911, and had been in cold storage since that date. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

April 10: Death from distemper. *Autopsy*.—The fascia was somewhat thickened but otherwise it seemed normal. It was closely adherent along the margins and seemed to blend with the tissues on the surface of the trachea.

Histology.—Microscopic examination: the sections showed normal, well-nourished fascia.

Comment.—In this group free fascia flaps were successfully transplanted into the subcutaneous tissue, into fat, on muscle, periosteum, bone, cartilage, tendons, and ligaments.

Microscopic examination of the specimens showed that the fascia retained its own structure after transplantation and was apparently healthy and well nourished. This was true even after being kept in cold storage for 35 days and then transplanted into another animal.

The clinical uses suggested by these experiments are of considerable importance, and cover a wide field.

Group II.—Transplantation of Free Fascia into Tendon and Muscle Defects.

EXPERIMENT 16.—Male, black mongrel, about six months old. *Operation*, December 19, 1910: The right tendo Achillis was exposed and a section about 2.5 cm. long was removed. The stumps were held in position by a strong tension suture, and then a flap of fascia lata was placed in the defect so as to surround the stumps like a tube. This tube was then drawn tight and the ends were securely sutured around the stumps. The tension suture was cut and the dead spaces obliterated. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

March 7, 1911: Distemper. Sacrificed. The animal had been very active and had no limp. It was impossible to tell which leg had been operated on without close inspection. *Autopsy*.—The replaced tendon was thicker than normal but seemed strong and satisfactory in every way (Fig. 1).

Histology.—Microscopic examination: cross section of the new tendo

Achillis showed normal staining fascia which was folded on itself. Surrounding the fascia was connective tissue, which caused the apparent thickening of the new tendon.

EXPERIMENT 20.—Male, white fox terrier, about four months old. *Operation*, January 3, 1911: The sartorius muscle was exposed and a section about 2.5 cm. long was removed. The muscle ends were held in position and a flap of fascia lata was sutured into the defect surrounding the muscle stumps by a tube of fascia. The dead space was obliterated and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

February 1: Death from pneumonia. Since the healing the animal had been very active and no difference could be detected in the gait. *Autopsy*.—The fascia was firmly united with the muscle ends (Fig. 2).

Histology.—Microscopic examination: the sections showed fascia with fibres and nuclei clearly stained.

Comment.—This group shows that muscle and tendon defects may be bridged by free flaps of fascia. Muscle defects may be bridged by means of fascia flaps and thus a certain amount of the muscle function saved. The fascia united firmly with the muscle ends and formed a strong symmetrical band between them.

The use of fascia flaps to replace tendons is of especial importance and most promising clinically. While it is a well-known fact that free tendon transplantation can be successfully done, it must be borne in mind that it is often difficult to secure either long or short pieces of tendon without doing considerable damage.

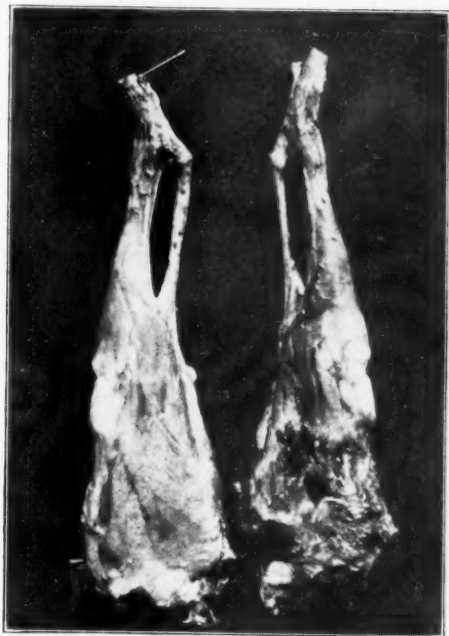
There are large amounts of fascia available in the body which can be secured without damage to any other working part. Thus tendons of any desired length might be made from strips of the iliotibial band of the fascia lata.

Experimentally the tendons made of folded strips of fascia are not liable to adhere to surrounding tissues. Fascia flaps might also be used to prevent tendons from being caught in scar tissue. The final results after replacing tendons with this material are more satisfactory than with any foreign material or transplantable tissue with which I am familiar.

Group III.—Transplantation of Free Fascia Around Vessels and Nerves.

EXPERIMENT 33.—Female, black and yellow mongrel, about one year old. *Operation*, February 14, 1911: The right jugular vein was dis-

FIG. 1.



Experiment 16.—Fascia to replace tendo Achillis. Operation, December 19, 1910. Specimen removed March 7, 1911. Comparison of new and normal tendons. The new tendon is thicker than the normal.

FIG. 2



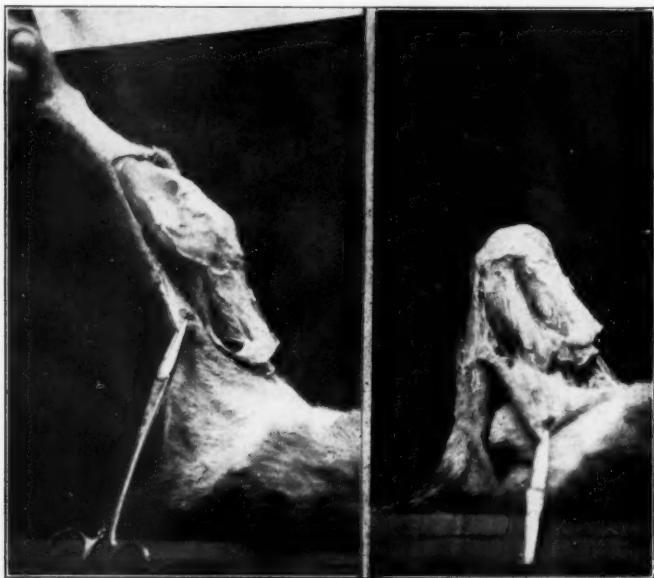
Experiment 20.—Fascia replacing defect in sartorius muscle. Operation, December 27, 1910. Specimen removed January 14, 1911. The thick muscle ends can be seen, and connecting them is the fascia which has united firmly to them.

FIG. 3.



Experiment 41.—Fascia around vessels and on trachea. Operation, March 14, 1911. Specimen removed April 11, 1911. On the right carotid can be seen a flap of fascia which was transplanted immediately from the same animal. On the left carotid and trachea are flaps of fascia from another animal which had been in cold storage for 35 days.

FIG. 4.



Experiment 22.—Fascia filling defect made by removal of patella. Operation, January 9, 1911. Specimen removed February 2, 1911. Note the amount of extension and flexion possible. The fascia can be seen firmly healed to the joint capsule.

sected out and a flap of fascia lata was wrapped about it. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

March 3: Death from pneumonia. *Autopsy*.—The fascia was thickened but otherwise seemed normal. It was quite adherent to the vessel wall. The lumen of the vessel was not encroached upon.

Histology.—Microscopic examination: the sections showed the structure of the vessel to be normal. It was surrounded by a band of fascia which was apparently well nourished and showed no signs of degeneration.

EXPERIMENT 41.—Female, yellow and white mongrel, about one year old. *Operation*, March 14, 1911: Both common carotid arteries were exposed. Around the right carotid a piece of fascia lata was sutured, which had just been removed from the right thigh. Around the left carotid was sutured a piece of fascia which had been removed from another animal on February 7, 1911, and had been in cold storage since that date. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

April 10: Death from pneumonia. *Autopsy*.—The fascia on both carotids was thickened, but otherwise seemed normal. The appearance of the two specimens was the same. The fascia was quite adherent to the vessels but could be stripped off. The lumen of the vessels was not encroached upon (Fig. 3).

Histology.—Microscopic examination: the sections showed apparently normal fascia in both instances. No signs of degeneration.

EXPERIMENT 44.—Male, black and white fox terrier, about one year old. *Operation*, March 21, 1911: The right sciatic nerve was exposed and a flap of fascia lata was sutured around it. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing. Gait unaffected.

April 20: Distemper, animal sacrificed. *Autopsy*.—The fascia was thickened but otherwise seemed normal. It could be moved on the nerve to a slight degree. There was no constriction of the calibre of the nerve.

Histology.—Microscopic examination: the sections showed a normal nerve surrounded by well-nourished, apparently normal fascia.

Comment.—This group shows that free flaps of fascia may be successfully transplanted around arteries, veins, and nerves, without in any way interfering with the lumen of the vessels or compressing the nerves.

Clinically, fascia flaps might be of use in protecting suture lines in vessel surgery and in reinforcing weakened areas in vessel walls. The site of nerve plastic operations might be surrounded and protected by such flaps. It might also be of use in protecting a nerve after it was freed from callus or scar tissue.

Group IV.—Transplantation of Free Fascia into Joints and for Suturing Fractured Bones.

EXPERIMENT 22.—Female, yellow mongrel, about six months old. *Operation*, January 9, 1911: The left patella was removed and a piece of fascia lata was substituted for it. The fascia was folded on itself so that its inner smooth surface was next to the joint, and also under the skin. It was sutured to the capsule and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

February 2: Pneumonia, animal sacrificed. The joint was freely movable and as far as could be seen had been as serviceable as the normal knee (Fig. 4). *Autopsy*.—The fascia was easily separated from the skin. It had adhered firmly to the joint capsule. On opening the joint the surface of the fascia was perfectly smooth. There were no adhesions. The fascia was slightly thickened.

Histology.—Microscopic examination: the sections showed a double thickness of apparently normal fascia. The staining of fibres and nuclei was well marked (Fig. 5).

EXPERIMENT 29.—Female, white fox terrier, about eight months old. *Operation*, February 6, 1911: The right knee-joint was opened and the entire articular cartilage was removed as thoroughly as possible. Then a piece of fascia lata was inserted and sutured over the denuded portion of the femur and well up under the patella. The joint was closed. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

February 27: Death from pneumonia. Since the dressing was removed the animal has been using the operated knee-joint without apparent discomfort. *Autopsy*.—The joint was movable. The fascia was slightly thickened. It was adherent to the denuded end of the femur but to no other portion of the joint. Its structure was well preserved (Fig. 6).

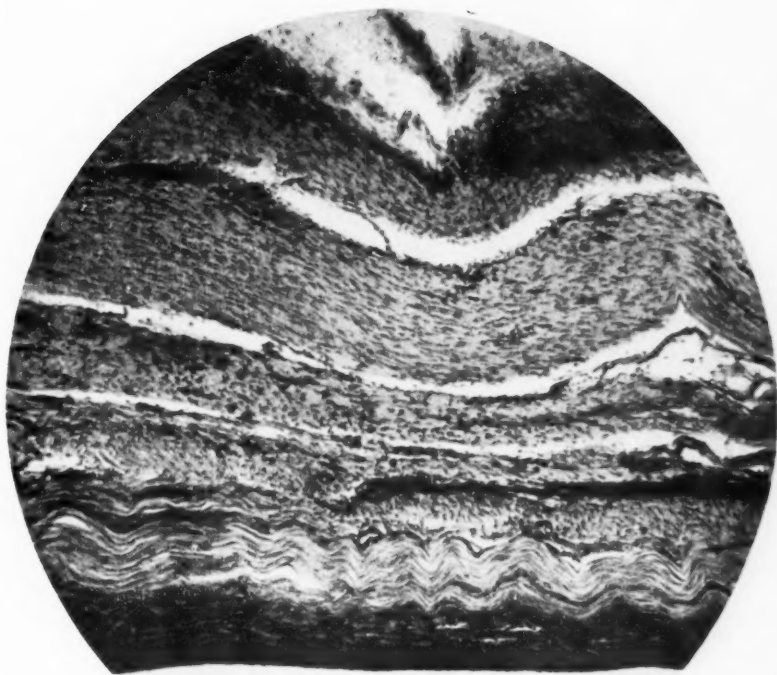
Histology.—Microscopic examination: the sections showed normal staining, well-nourished fascia. No signs of degeneration or absorption.

EXPERIMENT 31.—Male, yellow and white mongrel, about six months old. *Operation*, February 13, 1911: The right tibia was exposed and the periosteum stripped back. The bone was sawed through and then two strips of fascia lata were passed through drill holes and tied. The tied ends were made additionally secure by sutures. The wound was closed and a small drain inserted in the lower angle. Dry dressing, crinoline, and splint. Condition on leaving the table excellent. The stitches were removed on the fifth day. The wound was apparently nicely healed. It was practically impossible to immobilize the broken bone.

February 23: Distemper, animal sacrificed. *Autopsy*.—On removing the dressing the wound was found badly infected. In spite of the infection the strength of the fascia was apparently but little affected and the strips were still holding the ends of the bone together. This specimen was accidentally lost.

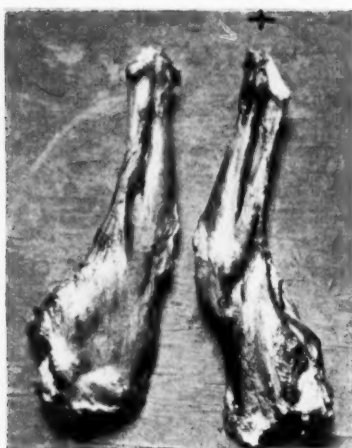
Comment.—This group is also interesting. Free flaps of fascia were successfully transplanted into joints and also to

FIG. 5.

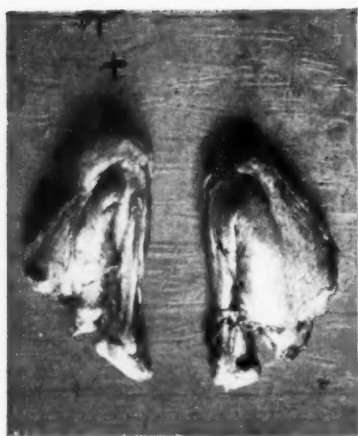


(Microphotograph, Zeiss. Obj. AA. Oc. 3.) Two layers of fascia filling defect left by removal of patella. Section cut parallel to fascia bundles. The smooth, dark, staining layer at the bottom of the plate is the portion toward the joint cavity.

FIG. 6.



a



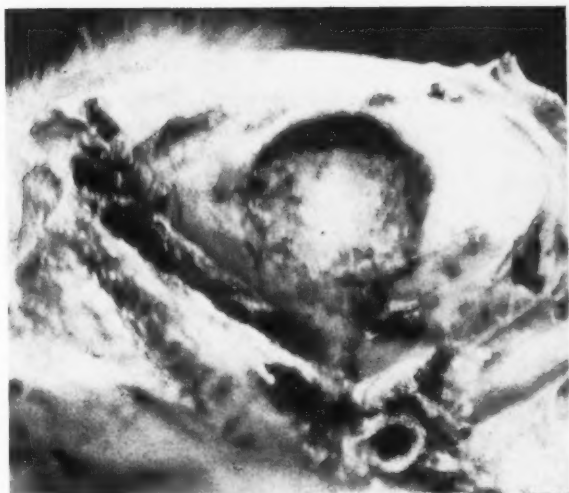
b



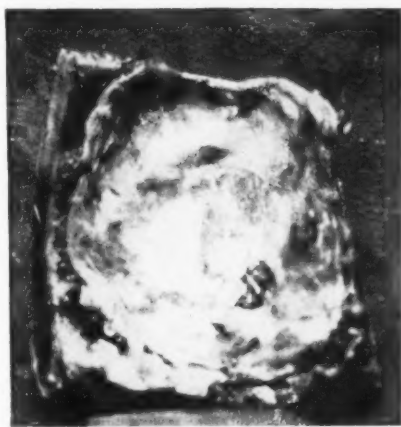
c

Experiment 29.—Fascia into joint after removal of the cartilage. Operation, February 6, 1911. Specimen removed February 28, 1911. (a) Leg extended, compared with normal; (b) leg flexed, compared with normal; (c) inside of joint. The + marks the operated joint.

FIG. 7.



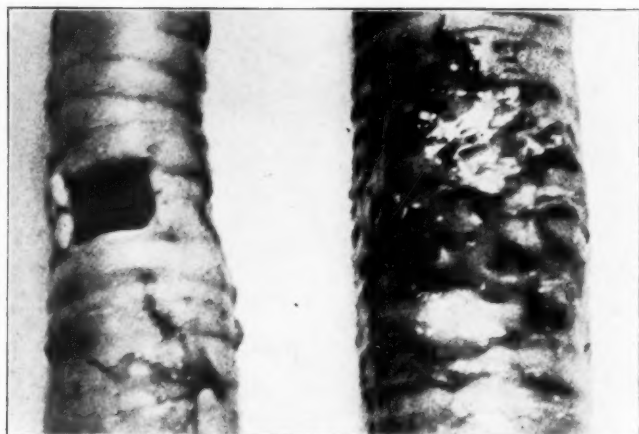
a



b

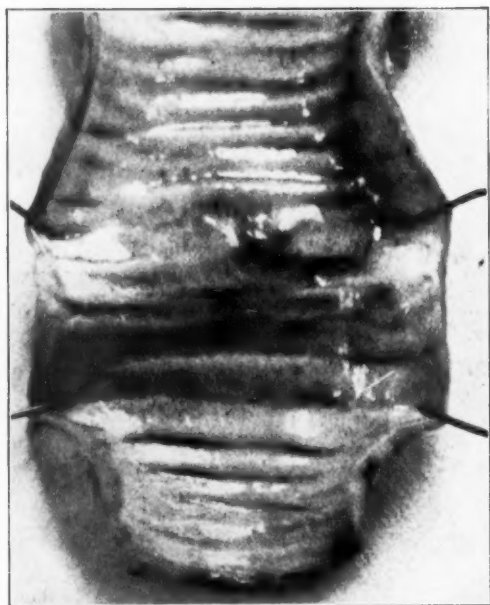
Experiment 38.—Fascia into skull and dura defect. Operation, March 6, 1911. Specimen removed April 20, 1911. (a) Bone defect from outside with fascia adherent to bone edges; (b) from within the outline of the bone defect can be seen. The fascia is closely adherent to the dura which extends beyond it. The fascia is smooth except for one small adhesion in the centre.

FIG. 8.



a

b



c

Experiment 62.—Fascia over defect in trachea. Operation, June 12, 1911. Specimen removed July 3, 1911. (a) Shows normal trachea with opening in it the size of that covered by the fascia; (b) the fascia healed over a similar defect; (c) the same specimen from within, showing a slight depression which marks the defect. The mucous membrane has grown completely over the fascia.

take the place of patellæ which had been removed. Both of these procedures are suggestive clinically.

Bones were fractured and the fragments sutured with strips of fascia. The results of these last experiments were unsatisfactory on account of the difficulty in immobilizing the fragments. However, the use of fascia strips in the open treatment of fractures in human beings may be of great use clinically, as immobilization can be secured.

The fascia does not act as a foreign body, and has strength enough to stand any reasonable strain put upon it.

Group V.—Transplantation of Free Fascia into Defects in the Skull and Dura, also into Tracheal Defects.

EXPERIMENT 38.—Male, yellow mongrel, about one year old. *Operation*, March 6, 1911: The left temporal muscle with the underlying periosteum was turned back and a three-quarter inch button of bone was removed. The dura under this area was excised and a flap of fascia lata was tucked under the bone edges. The smooth muscle side of the fascia was placed next to the brain. The temporal muscle was replaced and sutured, and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

April 20: Distemper, animal sacrificed. *Autopsy*.—There was one small adhesion of the cortex to the central portion of the fascia. The edges of the fascia and dura were intimately blended. The structure of the fascia could be plainly seen. The fascia was tightly stretched across the bone defect and was firm and did not bulge on pressure (Fig. 7).

Histology.—Microscopic examination: the sections showed normal staining, apparently well-nourished fascia.

EXPERIMENT 62.—Female, black mongrel, about one year old. *Operation*, June 12, 1911: The trachea was exposed and an area 8 mm. square was excised. Over this defect was sutured securely a flap of fascia lata. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing. There was no cough or any respiratory symptom following the operation.

July 3: Animal sacrificed. *Autopsy*.—The fascia was somewhat thickened and firmly adherent to the surface of the trachea. There had been no leakage whatever. On opening the trachea from behind, the defect was made out as a very shallow depression and the fascia seemed to be entirely covered with mucous membrane, which had grown over it (Fig. 8).

Histology.—Microscopic examination: the sections showed the defect filled by normal staining, apparently well-nourished fascia. Over this fascia, as a base, the mucous membrane had grown, completely covering it (Fig. 9).

Comment.—This group shows that flaps of fascia inserted in skull defects between the dura and bone edges will heal and give a strong membrane which will resist considerable pressure from within and without. When the dura is removed in addition to the bone, the fascia flap tucked under the bone edges will unite with the dura and also become tightly adherent to the bone edges.

There was in each instance a single fine adhesion of the cortex to the centre of the fascia flap.

Fascia flaps might be used clinically in repairing skull defects and as an aid in closing of spina bifida.

This group also shows that free flaps of fascia may be successfully used to cover prepared defects in the trachea, without subsequent infection, and that the mucous membrane grows across the fascia covering the defect.

It might be of use, clinically, in closing old tracheotomy wounds, where there has been considerable destruction of cartilage, and also in reinforcing sutures of the trachea.

Group VI.—Transplantation of Free Fascia into Prepared Defects in the Abdominal Wall.

EXPERIMENT 17.—Male, white and black fox terrier, about one year old. Operation, December 22, 1910. All the tissues of the abdominal wall between the skin and the peritoneum were excised from an area about 4 by 7 cm. Into this defect a flap of fascia lata 3 by 6 cm. was sutured. The skin was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

June 27, 1911: Animal sacrificed. *Autopsy.*—There was no hernia or bulging of the abdominal wall at the site of operation. From within there was no depression in the parietal peritoneum. On holding the specimen to the light the outline of the inserted fascia could be readily seen. The fascia itself was slightly thickened but normal in every way and was strong and tough.

Histology.—Microscopic examination: the sections showed normal staining fascia with no signs of degeneration.

EXPERIMENT 19.—Male, brown and black mongrel, about one year old. Operation, December 29, 1910: The peritoneum was exposed and an area 4 by 2 cm. was excised. Into this defect a piece of fascia lata was sutured. The wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

February 7, 1911: Animal sacrificed. *Autopsy.*—The fascia edges had blended with the peritoneum. It was thickened but otherwise seemed normal. There was a small omental adhesion.

Fig. 9.



(Microphotograph, Zeiss, Obj. AA, Oc. 3.) Longitudinal section of fascia covering a tracheal defect. The defect can be seen between the tracheal rings. On the right of the plate the fascia has become accidentally separated from the surface of the trachea during the preparation of the section. The mucous membrane can be seen covering the fascia.

FIG. 1c.



a



b



c

Experiment 19.—(a) Fascia in peritoneal defect. Operation, December 29, 1910. Specimen removed February 7, 1911. Experiment 23.—(b) Fascia on bladder. Operation, January 10, 1911. Specimen removed June 27, 1911. Experiment 61.—(c) Fascia over defect in intestine. Operation, January 5, 1911. Specimen removed July 3, 1911. In all of these the fascia was thickened. It was incorporated with the peritoneum, and there was a puckering of the peritoneum at the margin of the fascia. There was adherent omentum in each case. A small tag can be seen in a.

Histology.—Microscopic examination: the sections showed normal well-nourished fascia.

EXPERIMENT 46.—Male, yellow and white mongrel, about one year old. *Operation*, March 23, 1911: A section of the abdominal wall 3 by 7 cm., including everything except the skin, was excised. Into the peritoneal defect was sutured a flap of fascia lata from one thigh, and into the muscle defect, a flap from the other thigh. The skin was closed in the usual manner. Dry dressing. Condition on leaving the table excellent.

The animal developed distemper three days after the operation and on the fifth day the skin wound broke down. There was no hernia, as the fascia held firmly.

April 6: Death from distemper. *Autopsy.*—There was a crater-like ulcer, whose base was made up of fascia on which granulations could be seen both at the edges and scattered over the surface. There was no hernia whatever, and the fascia seemed to be strong and intact. On opening the abdominal cavity there was free pus, and this was also found in the pleural cavity. The omentum was adherent over a small part of the fascia. The fascia was incorporated with the peritoneum and had healed firmly in position.

Histology.—Microscopic examination: the sections showed infiltration with leucocytes, and marked signs of infection. The fascia was apparently in good condition with clearly stained fibres and nuclei. There was definite granulation tissue growing from the ulcer edges out on the fascia.

Comment.—This group shows that free flaps of fascia may be sutured into peritoneal and muscle-fascia defects in the abdominal wall, and that it will incorporate itself with the surrounding peritoneum and muscle edges. A small omental adhesion was present on examination of the specimen in each instance, but in no case was there adhesion of the gut or any other abdominal organ to the fascia.

When a hernia was produced by the removal of a portion of the abdominal wall, except the skin, it was readily cured several weeks later by the transplantation of fascia flaps.

These experiments suggest the use of fascia flaps in the cure of large herniæ, where the muscle is atrophied, and for strengthening any weakened area in the abdominal or chest wall. The facility with which the fascia unites with the peritoneum suggests its further use in pleural and pericardial defects.

Group VII.—Transplantation of Free Fascia onto Stomach, Intestine, and Bladder.

EXPERIMENT 23.—Female, brown and black mongrel, about one year old. *Operation*, January 10, 1911: The bladder was brought up through a midline incision, and a flap of fascia lata was sewed to it with a continuous suture. The bladder was dropped back and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

June 27: Animal sacrificed. *Autopsy*.—There were omental adhesions to the fascia. The peritoneum on the surface of the bladder was somewhat puckered under and immediately around the fascia edges. The fascia itself was thickened, but otherwise seemed normal.

Histology.—Microscopic examination: normal staining fascia was found. The peritoneal covering of the bladder could not be differentiated.

EXPERIMENT 24.—Female, yellow mongrel, about six months old. *Operation*, January 16, 1911: The stomach was exposed and an incision 3.5 cm. long was made in it, down through the mucosa. The incision was then closed with the Cushing continuous stitch, and over the suture line was placed and sutured a flap of fascia lata. The stomach was dropped back and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

January 27: Distemper, animal sacrificed. *Autopsy*.—The fascia was thickened but otherwise seemed normal. It was closely adherent to the stomach wall. There were a few omental adhesions to the fascia, but these could be easily separated.

Histology.—Microscopic examination: the sections showed the line of suture. Above this was the layer of fascia which was apparently normal and well nourished.

EXPERIMENT 61.—Male, black and white fox terrier, about one year old. *Operation*, June 5, 1911: A loop of gut was brought up through an abdominal incision and a purse-string suture was placed opposite the mesentery. When the suture was drawn tight and tied the portion within the suture projected outward. The tip of the projection was cut off, exposing the lumen of the bowel. Over this area a flap of fascia lata was sutured snugly and the gut was dropped back. The wound was closed in the usual manner. Dry dressing. *Per primam* healing.

July 3: Animal sacrificed. *Autopsy*.—The omentum was adherent to the fascia, but this was easily separated. The fascia was somewhat thickened, but otherwise seemed normal. It was closely adherent and seemed incorporated with the peritoneum of the bowel. There was a definite puckering of the wall of the gut around and under the fascia. There had been no leakage. From within a small depression in the mucous membrane could be seen corresponding to the pucker made by the purse-string.

Histology.—Microscopic examination: the sections showed normal staining, well-nourished fascia. There was marked infiltration of the tissue beneath the fascia with polynuclear leucocytes. There was a great

mass of these cells in the area corresponding to the made defect. On the surface of the fascia was the remains of the adherent omentum.

Comment.—This group of free fascia flaps were successfully transplanted onto the stomach, the intestine, and the bladder. The fascia seemed to incorporate itself with the peritoneum (Fig. 10).

Clinically fascia might be used to strengthen suture lines and weakened areas due to ulceration. It might also be of use in closing fistulæ of one sort or another.

Group VIII.—Transplantation of Free Fascia on Liver, Kidney, and Spleen.

EXPERIMENT 36.—Female, brindle mongrel, about eighteen months old. *Operation*, February 21, 1911: Through a lumbar incision the left kidney was exposed and after the capsule was stripped back an abrasion of the surface was made and a flap of fascia lata was sutured over it. The hemorrhage ceased promptly. The kidney was dropped back and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

March 7: Distemper, animal sacrificed. *Autopsy.*—The skin wound which had apparently healed became infected after the development of the distemper. The fascia was adherent to the surrounding tissues. It was not much thickened and seemed normal. It was tightly adherent to the kidney at the edges, but could be stripped up more easily in the centre of the flap.

Histology.—Microscopic examination: the sections showed normal fascia closely adherent to the parenchyma.

EXPERIMENT 52.—Male, black mongrel, about three months old. *Operation*, May 8, 1911: Through a high midline incision a lobe of the liver was exposed. The end of the lobe was cut off with scissors, leaving a bleeding area 3 cm. \times 0.6 cm. Over this surface was placed a flap of fascia lata and the bleeding was markedly checked. The fascia covered the end like a shallow cap, and was held in position by mattress sutures passing through the liver substance and through both sides of the fascia. These sutures were drawn as tight as desired, and did not cut through the liver substance. The liver was dropped back and the wound was closed in the usual manner. Condition on leaving the table excellent. *Per primam* healing.

June 6: Death from pneumonia. *Autopsy.*—There was adhesion of the omentum to the fascia. When this was stripped off the fascia was seen covering the denuded area like a cap. It was slightly thickened but otherwise seemed normal.

Histology.—Microscopic examination: the sections showed normal staining, well-nourished fascia surrounding an area of liver substance. It was adherent to a considerable extent.

EXPERIMENT 60.—Black and white fox terrier, about one year old.

Operation, June 5, 1911: The spleen was brought up through a left rectus incision, the edge was trimmed with scissors, and a flap of fascia was sutured over the denuded area so as to bind it. The fascia was held with mattress sutures, which passed through the spleen and both edges of the fascia. There was considerable hemorrhage until the fascia was applied and the sutures tied. The spleen was dropped back and the wound was closed in the usual manner. Dry dressing. Condition on leaving the table excellent. *Per primam* healing.

July 3: Animal sacrificed. *Autopsy*.—The fascia was thickened and securely bound the edge of the spleen. It seemed well nourished, and it could be separated from the spleen quite easily.

Histology.—Microscopic examination: sections showed normal staining fascia surrounding spleen tissue.

Comment.—In this group free flaps of fascia were successfully transplanted on the liver, kidney, and spleen. It suggests that the fascia flaps might be used to support sutures in these organs, and also to bind raw post-operative surfaces (Fig. 11).

It is to be noted that the fascia when applied to a bleeding surface seemed to have a definite hæmostatic effect, which is comparable to the hæmostatic action of bits of muscle, spoken of by Cushing.

The kidney might be suspended to the ribs or muscles in a sling of free fascia. These results are very promising.

REMARKS.—In none of the animals have I noted a muscle hernia after the fascia was removed, but should it occur the hernia could be repaired without difficulty. There is apparently no untoward effect after removal of the fascia lata as far as the use of the limb is concerned.

In every instance the fascia retained its own structure and seemed well nourished. After removal from its bed it was as tough and strong as when first transplanted.

The great strength of the fascia, and, in addition, its thinness and flexibility are to be noted. It can be sutured into a defect under considerable tension, and the sutures will hold securely even when inserted close to the edges or ends of the flap.

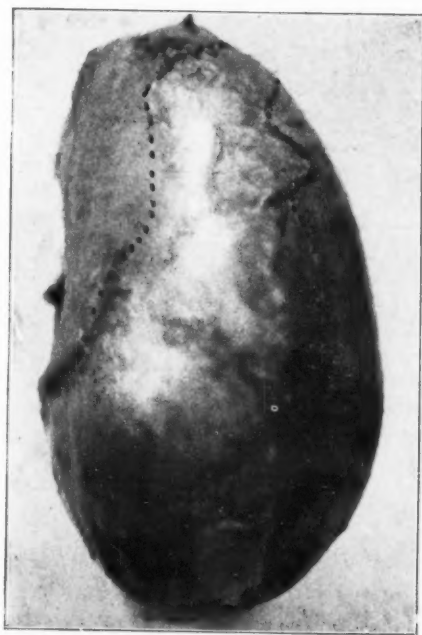
The great supply of this material and the ease with which it can be obtained are important points.

There is some difference in the measurements of flaps of

FIG. 11.



a



b

Experiment 25.—(a) Fascia on a lobe of the liver. Operation, January 17, 1911. Specimen removed January 26, 1911. The fascia was thickened, but was adherent to the liver surface over most of its extent. Experiment 36.—(b) Fascia on kidney cortex. Operation, February 21, 1911. Specimen removed March 7, 1911. The fascia is closely adherent to the kidney substance and blends with the capsule.

In both of these specimens, as in all the others, the fascia was well nourished.

FIG. 12.



(Microphotograph, Zeiss, Obj. AA, Oc. 3.) Fascia preserved in cold storage wrapped in moist salt gauze for 35 days, and then transplanted on the surface of a trachea. Operation, March 14, 1911. Specimen removed April 10, 1911. The section is cut across the fascia bundles. The fascia is normal in appearance and stains well.

fascia before and after removal. For example, a marked out flap of fascia lata measured 4.5×2.5 cm. before removal, and after removal it measured 3.3×2 cm. Another flap measured before removal 4.5×2.2 cm. and after removal 4×1.75 cm.

In several experiments fascia was drawn taut and sutured around firm rubber tubes 0.8 to 1 cm. in diameter, and then inserted in the subcutaneous tissue. These specimens were removed after 49 to 54 days. The structure of the fascia could easily be seen. Microscopic examination showed normal staining fascia with no signs of degeneration.

This is interesting, as it shows that fascia will receive sufficient nourishment if only one surface is exposed to living tissues.

The type of so-called distemper prevalent in the laboratory this winter appeared to have some effect on the healing of the wounds, and a number of them became infected. This did not seem due to a break in technic, as other animals operated on the same morning (before and after these animals), with identical technic, and not developing the distemper, did not break down.

In several animals whose stitches had been removed after *per primam* healing, the skin wound subsequently broke down after the development of distemper.

In the instances where there was infection, the transplanted fascia seemed particularly resistant to it, and retained its structure after breakdown of the surrounding tissues.

Where there was tension on the fascia there was comparatively little thickening, but wherever the fascia was simply laid on a tissue there was always thickening, and unless it was held flat with sutures it had a tendency to bunch or roll up.

Once or twice the fascia flap was accidentally allowed to partially dry out before it was transplanted, but in spite of this it was moistened with salt solution and transplanted. The results were excellent and the fascia was nourished and grew in its new position.

The question naturally arose as to the necessity of transplanting the fascia immediately, and also whether fascia from one animal could be successfully transplanted into another.

Experimentally, both of these questions have been answered satisfactorily (Fig. 12).

Fascia was successfully transplanted into the same and other animals after being kept in an ordinary ice chest, 38° for as long as 7 days; in cold storage 32° wrapped in gauze moistened with salt solution for 35 days, and in cold storage 32° in normal salt solution for 56 days.

I am sure that the number of days given here do not show the greatest time that fascia may be preserved by the methods spoken of, but I mention the periods as a suggestion that suitable fascia might be preserved until needed for clinical use.

Fascia kept in salt solution appeared oedematous when first removed from the solution, but the oedema disappeared when the tissue was pressed with dry gauze. The oedema was entirely in the superficial connective tissue, which had not been removed. The fascia kept in moist salt gauze, on the other hand, was normal in appearance.

When fascia was sutured to the surface of the stomach, intestine, or bladder, within a few days there was the appearance of puckering or drawing up of the surface under the fascia and at its edges, somewhat similar to the effect of ordinary collodion on the skin. On this area, from within the organ, this puckering was not to be found and the lumen was in no way encroached upon.

The hæmostatic action of free fascia flaps is noteworthy.

CONCLUSIONS.—The foregoing experiments give an idea of the great possibilities of transplanting free flaps of fascia, and many suggestions for the clinical use of this substance may be drawn from them.

I feel convinced that many of the difficult situations arising during operations for the repair of weakened and defective tissues or for the control of bleeding surfaces will be simplified by the use of free fascia flaps and shall report the results of its use in such cases with a consideration of the literature in a subsequent paper.

EXPERIENCES IN THORACIC SURGERY UNDER ANÆSTHESIA BY THE INTRATRACHEAL INSUFFLATION OF AIR AND ETHER.*

WITH REMARKS ON THE VALUE OF THE METHOD FOR GENERAL ANÆSTHESIA.

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ABOUT two years ago, Meltzer and Auer first described the method of artificial respiration by the intratracheal insufflation of air. In later publications they showed that in animals the method was of great value for experimental investigations in which one or both pleural cavities had to be opened. They described a very simple method by which the animals could be anæsthetized by intratracheal insufflation of air and ether, and expressed their belief that the method would be of great value for thoracic surgery in the human being. Soon afterward, Carrel made use of the method for his operations upon the heart and aorta of dogs, and recommended it for intrathoracic experimental work. At the same time, the writer had been making a large number of investigations on dogs, and with the aid of Dr. Neuhof had performed a not inconsiderable number of operations upon the lungs, the bronchi, and the œsophagus in these animals. Thus we removed one or several lobes of one or both lungs, made incisions into bronchi, with subsequent suture, etc. In all of these operations the method of intratracheal insufflation worked admirably. One or both pleural cavities could be widely opened, and all the necessary intrathoracic manipulations performed and the animals remain in good condition throughout the operations. After the thoracic wall had been closed by suture and the intratracheal insufflation stopped and the intratracheal tube removed, the animals began to breathe again in a perfectly

*Read before the Philadelphia Academy of Surgery, May 3, 1911.

normal manner. Unless death occurred from sepsis or followed from an unsuccessful operative procedure, the animals recovered entirely. When the dogs were killed days, weeks, or months after the operations, the larynx, trachea, and lungs were found in perfectly normal condition.

As has been described in previous papers, the insufflation was carried on by means of a very simple apparatus which had been devised by Meltzer and Auer, and no care was taken to filter, warm, or moisten the air which was blown into the trachea. Nevertheless no lesion could be found post mortem in the respiratory tract of these dogs. The anæsthesia was a very good one and seemed to be absolutely devoid of danger. It is well known that it is easy to kill a dog by means of ether given by inhalation, but we have found it impossible to kill the animals with ether given by intratracheal insufflation. This safety is probably due to the fact that so much of the ether escapes upward in the trachea and out through the larynx and mouth.

In previous papers, I have described a simple and portable apparatus for intratracheal insufflation anæsthesia in man. In what follows I shall give an account of our experiences with the method for general anæsthesia and shall report upon the cases of intrathoracic surgery which we have had up to the present time.

The Value of Insufflation Anæsthesia for General Surgery.—We have, at Mt. Sinai Hospital, New York, anæsthetized about 200 patients by means of intratracheal insufflation, and have found the method very valuable for a great many operations. In all but a few cases, the anæsthesia was a very satisfactory one, particularly free from complications and after effects. It is very easy to keep the patients under full anæsthesia, vomiting has never occurred during the anæsthesia, and the patients were never too deeply under the ether. At the conclusion of the operations, the patients awakened very rapidly, especially if pure air was insufflated for a few minutes before the intratracheal catheter was withdrawn. Vomiting after the operation was very unusual no matter what the surgical procedure that had been performed, and the pa-

tients never complained of pain or discomfort in their laryngeal regions. We have thus far not seen any pulmonary complications after insufflation anæsthesia.

In one patient, we failed to obtain complete muscular relaxation so that the necessary intra-abdominal manipulations could be accomplished.

In the case of a young girl, who was to be operated upon for chronic appendicitis, it was found impossible to cause complete relaxation of the abdominal walls. We finally attempted to obtain complete anæsthesia by means of ether given by inhalation, but the patient still struggled. Only when chloroform was given by inhalation was perfect relaxation obtained.

This patient was evidently one who was refractory to ether. It is possible that the intratracheal tube that we used was too small, so that too much of the air and ether mixture escaped by the side of the tube.

Operations under insufflation anæsthesia were performed upon patients suffering from a variety of acute and chronic surgical diseases. Our experience up to the present time will allow us to mention the following operations in which we have found the anæsthesia of especial value. In operations upon the neck and more especially those around the trachea such as thyroidectomy, the method is very useful. Not only is the anæsthetizer never near the field of operation, but the operator can work around the trachea without causing any interference with the breathing. There is no danger of sudden collapse of the trachea when a large goitre has been removed, and no matter how much the trachea is handled, the anæsthesia continues smoothly and evenly. Intratracheal anæsthesia should be very advantageous for the operation of laryngectomy. The intratracheal tube could either be introduced through a tracheotomy wound and the trachea packed with gauze above this point, or the tube could be passed through the glottis in the usual manner, and removed only at the moment when the trachea is to be divided across after the entire larynx is free.

We have found that operations upon the face and jaws and mouth, where the buccal cavity or pharynx has to be in-

vaded, are made more easy and safe when done under insufflation anæsthesia. No blood or secretions can run down the trachea, for the out-flowing current passing upward in the trachea blows out any fluid that might run down into the larynx.

In operations upon the brain and spinal cord where the patient must often be placed in the prone position, the anæsthesia is very useful. As soon as the intratracheal tube has been introduced and the insufflation has been begun, the patient's head and body can be placed in any position desired and the anæsthesia given from a distance. The anæsthetizer need not be seated underneath the table as is ordinarily necessary.

Experiences with Insufflation Anæsthesia in Thoracic Surgery.—Insufflation anæsthesia is a positive pressure method and was primarily suggested for intrathoracic surgery. On account of the simplicity and apparent safety of the method it may take the place of all the more complicated positive and negative pressure cabinets. The operations upon animals gave such very satisfactory results, that we were very hopeful that the method would give as good results in thoracic operations in the human being. We were very careful in our first human operations, but, with increasing experience, have gained more and more confidence in the efficiency of insufflation in man. In the following are recorded the experiences we have had up to the present time:

CASE I (Reported in the ANNALS OF SURGERY, July, 1910).—*Abscess of the lung; thoracotomy and aspiration of the lung under intratracheal insufflation. Recovery.*

B. F., a butcher, fifty-five years of age, was referred to the II Surgical Service by Dr. Manges with the diagnosis of an abscess of the middle lobe of the right lung.

February 14: The patient was anæsthetized with ether, and the attempt was made to introduce a small catheter into the trachea. The patient took the ether very badly, and I did not have on hand the proper kind of a tube nor the necessary instruments for the intubation. After a number of unsuccessful attempts to pass a catheter through the larynx we determined to put off the intubation until a later time. The operator (Dr. Lilienthal) then resected four inches of the eighth and ninth ribs and packed the wound cavity with gauze.

February 20: Operation by Dr. Lilienthal, intratracheal insufflation

by Dr. Elsberg. Ether anæsthesia; larynx and pharynx thoroughly anæsthetized with cocaine. A soft rubber tube, No. 28 French scale, was passed through the glottis by means of a laryngeal forceps and pushed downward until a slight resistance was encountered. The tube was then fixed to the upper teeth by means of a gag. The tube was connected with the insufflation apparatus and a mixture of air and ether blown in under a pressure of 15 mm. of mercury. The patient began to cough violently, therefore the intratracheal tube was withdrawn about one inch. The coughing ceased at once, and at the same time all evidences of mucus in the trachea or pharynx disappeared. The patient's color was good, respirations regular, pulse of good quality. The patient was now turned on the left side and the operation begun.

3.10—No cyanosis, pulse 120; incision 12 cm. in length into right pleural cavity; pulse unchanged, color good, no cough. Pressure of current now raised to 20 mm. Palpation of the lobes of the right lung.

3.20—Pulse 108; respirations 48; color good with slight cyanosis; pleural cavity is wide open.

3.25—Heart action excellent; pulse 96; color good, no cyanosis; aspiration of middle lobe of lung.

3.30—Pulse 105; respirations 42; color good.

3.35—Pulse 108; respirations regular, 40. The current of air is interrupted several times in order to observe the appearance of the lung. When the current is prevented from entering the intratracheal tube the lung collapses and is of a dark green mottled color; when the lung is markedly distended (25 mm. pressure) the lung is of a bluish color with areas of red. When the lung is collapsed the œsophagus and aorta can be seen and examined.

3.40—Suture of incision in pleura. While the last stitches are being passed the pressure is raised to 30 millimetres in order to slightly over-distend the lung so that as little air as possible shall remain in the pleural cavity.

3.45—Pleura closed with small drain; pulse 132 and of good quality.

3.50—Color good, no cyanosis; respirations 32.

3.55—Suture of muscles and skin; voluminous dressing. The intratracheal tube is withdrawn. Pulse now 120, of good quality; respirations regular, no cyanosis.

Four minutes after the patient was taken to his bed he was awake. He said that he did not have any pain in his larynx; he was not hoarse. The morning after the operation the patient was in very good condition. He complained of some pain in the right chest and had considerable mucopurulent expectoration. He was not hoarse and did not complain of any pain in his laryngeal region. The auscultation of the right side of the chest through the bandages was not satisfactory, but breathing sounds could be heard over the entire side.

From this time on the patient steadily improved, the cough and expectoration grew less daily; he was out of bed on March 10 and was discharged from the hospital with his wound almost healed on March 25. When last seen (April 22) he was in excellent condition; the breathing sounds over the right side of the chest seemed normal; he

had almost no cough and practically no expectoration; he had gained considerable flesh and strength.

The patient returned to the hospital about six months later on account of a large pulmonary hemorrhage. He had another large hemorrhage from the lungs soon after his admission, to which he succumbed. No autopsy could be done.

CASE II.—John H., fifty-two years of age, admitted to Mt. Sinai Hospital on January 2, 1911, with the history of increasing difficulty in swallowing for ten months. He had lost 40 pounds in weight and was able to swallow only small quantities of fluids. The stomach tube was arrested 12 cm. from the teeth, and an X-ray picture taken after the ingestion of bismuth showed a marked narrowing of the œsophagus at this point.

On January 7 the patient was anesthetized with ether in the usual manner, a catheter No. 24 French introduced into the trachea, and intratracheal insufflation begun. The patient was turned on the right side, and an incision was made in the seventh intercostal space from the costal cartilage in front to the angle of the ribs behind (Dr. Elsberg). The incision was deepened through the muscles until the pleura was exposed. The lungs were now momentarily collapsed while the incision in the pleura was made. The ribs were now drawn apart by means of the rib spreader and the left pleural cavity widely exposed. The lungs were of a mottled pink color and moderately distended (pressure 30 mm.). Pulse slow and of good quality; very superficial respiratory movements. The lung was now carefully drawn toward the median line and the pericardium exposed; this was also drawn to the right so that the root of the lung was visible as well as the aorta and the œsophagus with the left vagus nerve.

About five inches above the diaphragm there was a hard nodular tumor of the œsophagus of the size of a large plum. There were no enlarged glands at the root of the lung. The tumor was free on all sides excepting where it lay against the aorta. The attempt was made to free it from its attachments to the aorta, but this was found impossible without great danger to the wall of the vessel. The tumor was, therefore, considered inoperable.

The incision in the pleura was closed by a fine running catgut suture, with interrupted sutures of strong catgut around the adjoining ribs. When the last stitches in the pleura were being

passed, the anæsthetizer was instructed to raise the pressure to 50 mm. of mercury, so as to distend the lung and expel as much air as possible from the pleural cavity. Then followed suture of the intercostal and pectoral muscles and skin in the usual manner. Large vaseline gauze dressing.

During the entire operation, which had lasted 57 minutes, the patient was in good condition; color of face pink, breathing superficial, pulse of good quality. Insufflation of pure air for three minutes at end of operation; then removal of intratracheal catheter.

Five minutes later the patient was awake and responded to questions. Four hours after the operation the respirations were 24 to the minute, and upon auscultation through the dressings, breathing sounds could be heard all over the left chest.

Convalescence thereafter was smooth and uncomplicated; the patient never had any respiratory difficulty; his pulse and respirations were practically normal; he was sitting up in bed on the third day after the operation.

On the evening of the sixth day after the operation, his temperature suddenly rose to 102° , and he suddenly complained of severe pain in the left chest, his pulse became very rapid and feeble. In spite of active stimulation he soon went into a condition of collapse and died a few hours later.

The post-mortem examination showed that there had occurred an infection of the pleural cavity by direct extension from the ulcerated carcinoma of the œsophagus.

Remarks.—From the stand-point of the insufflation, the operation was highly successful, and all the manipulations within the chest were accomplished with perfect ease. The lungs were distended and collapsed at will, and all parts of the pleural cavity could be well exposed. At no time was the operator disturbed by violent movements of the lung; the slight respiratory movements which the patient made were not at all communicated to the lung, which remained practically immobile. The fatal outcome was probably due to an infection from the ulcerated tumor, although an operative infection may have occurred.

CASE III.—*Abscess of the lung in a man of twenty-four years. Chronic abscess of the middle lobe of the right lung.*

Marked cyanosis during the preliminary ether anæsthesia by inhalation. Color became good as soon as the insufflation anæsthesia was begun; pulse good during the entire operation. Thoracotomy; incision of the lung; drainage of an abscess cavity in the middle lobe of the right lung (Dr. E.). Uncomplicated convalescence with persistence of bronchial fistula. Death after several months from a metastatic abscess of the brain.

CASE IV.—Female. *Bronchiectatic abscess of the right lower lobe.* Thoracotomy and exploration of the lung (Dr. E.) under insufflation anæsthesia (pressure 25 to 35 mm.). Condition of patient good during entire operation. The abscess cavity had emptied itself before the operation and could not be found.

CASE V.—Female. *Metastatic abscess of the lung after an infarct following another operation.* Intratracheal insufflation, thoracotomy and drainage of abscesses in left upper and lower lobes (Dr. E.). Condition of patient during operation good. Breathing movements ceased as soon as pressure is raised to 40 mm. of mercury. Recovery from the operation rapid and uncomplicated, but fever persisted. Patient died about six weeks after the operation. The autopsy showed that there were numerous abscesses that had not been drained.

CASE VI.—Female. *Interlobar empyema.* Thoracotomy and drainage under insufflation anæsthesia (Dr. Gerster¹). Recovery.

CASE VII.—Female. *Gangrene of the lung.* Intratracheal insufflation anæsthesia. Marked cyanosis during preliminary anæsthesia; insufflation of air, oxygen, and ether. Color pink after insufflation was begun. Thoracotomy and drainage of gangrenous areas in right lung (Dr. Gerster¹). Insufflation anæsthesia very satisfactory; satisfactory recovery from the operation itself. Death about one week after the operation from exhaustion from the sepsis.

CASE VIII.—Male. *Interlobar empyema.* Intratracheal insufflation. Thoracotomy and drainage (Dr. E.). Insufflation anæsthesia very efficient; lungs could be distended and collapsed at will. General condition of patient remained good during the entire operation. Uncomplicated recovery.

CASE IX.—Female, operated upon in Worcester, Mass. *Recurrent carcinoma of chest-wall* after extirpation of breast for carcinoma seven years before. Insufflation anæsthesia; catheter

¹ I am indebted to Dr. A. G. Gerster for permission to include his two cases.

No. 24 F. used; pressure 25 mm. of mercury. Radical extirpation of affected area of right chest-wall with parts of two ribs and of the sternum. Large opening in right pleural cavity. When pleura was opened, lungs were found moderately distended and immobile. Opening in pleura closed by continuous suture of fine catgut; while last stitch was passed pressure raised to 40 mm. so as to expel as much air as possible from the pleura. Suture line of pleura covered by a muscle flap from the serratus. Suture of skin with the aid of plastic flaps; large vaseline dressing. Anæsthesia and operation uncomplicated; pulse 90 to 100 during operation; slight respiratory movements during entire insufflation. Patient awake before she had been removed from the operating table. Convalescence thus far uneventful.

In all of the thoracic operations above reported, as well as in a large number of thoracotomies for empyema that we have done, the anæsthesia was a very good one. In not a single instance were any changes in the patient's condition observed when the pleural cavity was first opened; the pulse remained regular and of good quality and the patient's color remained good. In several of the cases, there were adhesions between the visceral and parietal pleuræ, but in most of the patients whose histories are given above, there were no adhesions, and the practically normal pleural cavity was invaded. We have not yet had occasion to operate upon a patient in whom both pleural cavities have to be opened. Such a case would be the supreme test of intratracheal insufflation. There is, however, every justification for the belief—based upon the results of animal experiments in which both pleural cavities were widely opened, and upon the experiences we have had with insufflation as a method of artificial respiration in several patients in whom all respiratory movements had been abolished—that it will be safe to open both pleural cavities if necessary, as far as the dangers from the double pneumothorax are concerned. The cases here reported are too few to allow one to draw final conclusions, but they do indicate that in the method of intratracheal insufflation we have at last a simple method for the avoidance of those dangers which have prevented the development of surgery of the intrathoracic viscera.

STUDIES ON PERITONEAL ADHESIONS.

WITH A CONTRIBUTION TO THE TREATMENT OF DENUDED BOWEL SURFACES.

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THE problem of peritoneal adhesions is one that merits the serious consideration of everyone engaged in abdominal surgery. That this fact is generally recognized is indicated by the large number of valuable contributions to the subject—including not only elaborate experimental researches of the most diversified sort, but also carefully recorded clinical observations—contained in the literature of the past twenty-five years. The results of all this work have been both gratifying and disappointing; gratifying in so far as certain valuable procedures have been both scientifically and empirically established, but disappointing in that the work is still unfinished, and is, indeed, in a state of confusion as regards the actual worth of numerous procedures very commonly employed and from time to time enthusiastically advocated; often it appears, without adequate scientific justification.

It is the purpose of this communication to present a collective and analytical review of this voluminous literature, classified along practical, common-sense lines, to impartially weigh the evidence, and to draw such conclusions as seem warranted. In connection with this critical study I shall describe a new and original method of dealing with denuded bowel surfaces.

Much of the existing confusion could have been avoided, it seems to me, if investigators had kept in mind the fact that peritoneal adhesions, like bacteria, are of two kinds—those which are useful and of essential worth to mankind, and those which are harmful and inimical to life or health. They represent in every instance nature's best method of defense or

of repair. Moreover, as we shall see later on when we come to consider the pathological processes involved in their formation, it is highly probable that they will always remain a necessary part of abdominal surgery, and that we can never hope to discover a prophylactic or curative agent that will prove to be a panacea for all cases. Indeed, it seems to me that efforts along this line are fundamentally wrong, and that they represent misdirected energy. For whenever and however the peritoneum is injured it must be repaired, if the individual is to survive. But the very processes involved in this repair include, in many instances, the necessity of adhesion formation. The search after some specific and potent remedy for this, therefore, represents no less ambitious an undertaking than to provide nature with a substitute method of repair in the peritoneal cavity that possesses improvements over her own! Now it is very obvious that this is impossible, and that the abdominal surgeon must accept the inevitable, and equip himself to reckon intelligently with peritoneal adhesions as a vexing but necessary part of his work. It will be found in the last analysis that he has recourse to three classes of procedure: (1) measures which prevent adhesions; (2) measures which restrict their formation to the harmless variety; and (3) measures which aid in their absorption.

Before discussing systematically the various procedures belonging to each of these classes, let us recall briefly several characteristics of the peritoneum itself which have an important bearing upon this problem.

First of all, we are apt to forget the enormous area of this serous membrane which has been estimated to be only slightly less than that of the skin. Again its remarkable absorptive power is so striking that it has actuated a number of investigators to undertake elaborate and laborious researches to determine its mechanism. It is conceded by all that the lymphatic absorption is most active in the upper part of the abdomen, especially on the under surface of the diaphragm and in the omentum, while in the pelvis it is relatively sluggish—a fact now commonly taken advantage of by surgeons in

the use of the Fowler or sitting posture in the treatment of peritoneal infections. Furthermore, it is generally admitted that solid particles—such as coloring matter in suspension, bacteria, oil globules, etc.—are taken up by the lymphatics. But concerning the process of absorption of fluids and soluble substances, there is some difference of opinion as to whether it occurs through the blood-vessels or the lymphatics. Starling and Tubby¹ introduced into the peritoneal cavities of dogs salt solution colored with indigocarmine, and methylene blue, and noted the time of its appearance respectively in the thoracic duct and in the urine. They found that it appeared much earlier in the urine, from which they concluded that the absorption had been through the blood-vessels. Mendel² later confirmed these observations, using the same methods. Hamburger³ studied the effect of ligating the left innominate vein—*i.e.*, practically the thoracic duct—upon absorption of fluids of different osmotic pressures introduced into the peritoneal cavities of rabbits, and concluded that the lymphatics play a very small part in the process of absorption. Orlow⁴ concluded that the blood capillaries are the essential paths of fluid absorption. By introducing a measured quantity of fluid into the abdominal cavities of dogs and withdrawing the remainder after a few hours, he observed invariably that a large amount had been absorbed, while the flow of lymph through the thoracic duct, measured before introducing the fluid and after its withdrawal, remained the same. Heidenhain⁵ corroborated this work, and reached the same conclusion. Cohnstein⁶ noted some increase in the flow of lymph from the thoracic duct after introducing fluid into the abdominal cavity, but thought it entirely out of proportion to the amount absorbed. His results in the main, however, agree with those of Orlow and Heidenhain. Klapp⁷ also concluded from his experimental work on dogs that soluble substances are absorbed from the peritoneal cavity chiefly through the blood-vessels. This imposing array of evidence seems quite convincing until one comes to consider the contribution of Meltzer⁸, who, contrary to Starling and Tubby and Mendel, observed that solutions

of coloring matter introduced into the peritoneal cavity appeared earlier in the thoracic duct than in the urine, and especially the more elaborate communication of Adler and Meltzer.⁹ These authors concluded from numerous experiments that ligation of the lymphatic ducts in rabbits does exert a restricting influence upon the quantity of fluid disappearing from the abdominal cavity, but that such experiments do not indicate whether or not the lymphatics carry away a part of this fluid. They found further that potassium ferrocyanide and strychnine are carried away mainly, if not exclusively, by the lymphatics. Their criticism of the work of Hamburger, Orlow and Heidenhain is, it seems to me, well-founded; and I quite agree with them that the conclusions of these authors are not justified from their work. They very cleverly point out the possibility of the interstitial tissue spaces as a system to be considered independently of the blood-vessels and the lymphatics, into which fluid may enter from the peritoneal cavity by filtration and osmosis; that from here it has three avenues of escape: (1) it can spread into the interstitial spaces of neighboring regions, and either not affect the blood- and lymph-vessels at all, or affect the blood-vessels sufficiently to reduce transudation into this region; (2) it can enter the blood-vessels through the walls of the capillaries or veins; (3) it can enter the lymphatics through the walls of the lymph capillaries. They call attention further to the fact that the contents of the thoracic duct may be quite different from the tissue fluids, the latter being a mixture of at least three components, viz., transudate from the blood-vessels, this minus the elements used in anabolism, and the products of catabolism. It becomes evident, therefore, that the interstitial tissue spaces may be conceived of as a system of reservoirs into which fluids or solutions of coloring matter are poured from the peritoneal cavity, probably largely by filtration and osmosis; and further, that the conclusions of Hamburger, Orlow, Heidenhain and others, based upon experiments which assume that the disappearance of these substances from the peritoneal cavity is equivalent to their direct and immediate transfer either to the lymph or

blood capillaries, and which utilize the flow of lymph through the thoracic duct as an accurate indicator of the extent to which the lymphatic system participates in the process of absorption, are entirely unwarranted.

It seems to me highly probable that both the lymph and blood capillaries participate in the removal of fluids and soluble substances from the interstitial spaces, but that the experimental work thus far done does not warrant a dogmatic statement that either system is entirely concerned in the process to the exclusion of the other. It must be remembered, too, that it has been repeatedly shown that the pressure in the peripheral veins is considerably greater than that in the lymphatic vessels—the latter constituting a system of drainage channels with a pressure approaching that in the great vessels near the heart; and that the pressure in the interstitial spaces is probably somewhere between that in the peripheral veins and the lymphatic vessels; a fact which acquires added significance when it is undertaken to show that the chief absorption of fluids is through the venous channels.

In this connection it is well to recall further that it has now been definitely established through the work of MacCallum,¹⁰ Kolossow,¹¹ Muscatello,¹² and others that the endothelial covering of the peritoneum is continuous, and not perforated by numerous *stomata* and *stigmata*, or direct channels of communication between the peritoneal cavity and the lymphatic vessels, as was until quite recently generally taught.

Closely allied with its remarkable absorptive power, is the well-known ability of the peritoneum to successfully cope with an astonishing amount of infection without itself being seriously or permanently damaged. It has been repeatedly shown that enormous numbers of virulent bacteria in pure culture can be injected directly into the peritoneal cavities of dogs without producing any serious consequences. And, as everyone knows, during the course of a large percentage of abdominal operations the peritoneum becomes soiled with bacteria, the destruction of which the surgeon confidently leaves to nature. Another familiar characteristic of the peri-

toneum is the remarkable variation in sensibility exhibited by different portions—in a general way the visceral part being entirely insensitive to pain, pressure, heat and cold, while the parietal portion is everywhere exquisitely responsive to these sensations. This was elaborately worked out by Lennander.¹³ Cushing¹⁴ had previously called attention to the fact that this same difference holds true for inflamed as well as healthy peritoneum, an observation that has been frequently corroborated by others since. Samson¹⁵ observed during the course of operations upon the lower end of the ureters that they are painless when pinched, cut, or sutured, unless traction is exerted on the parietal peritoneum. Broese¹⁶ very recently corroborated Lennander's views with reference to the pelvic organs in a most convincing way. In a case of vaginal fixation of the uterus, done under local anæsthesia, he found that the ovaries, tubes, and body of the uterus are insensitive to pain, pressure, heat, and cold. He amputated the tube and resected the uterine cornua without discomfort to the patient. But any traction, such as was required to deliver the uterus into the vagina, was extremely painful. Mitchell¹⁷, whose large experience in laparotomy under local anæsthesia entitles him to speak with authority upon this subject, has just published an excellent review of the literature of the past ten years, together with some very interesting observations of his own. It is quite evident from his paper that the controversy is still going on actively between the adherents and opponents of Lennander's views. His conclusions accord with the latter, and furthermore, he met with an encouraging measure of success in systematically analyzing abdominal pains before laparotomy, in an effort to diagnosticate both the location and the cause of this sensation. The recently conducted elaborate dissections of Ramström¹⁸ have gone far toward furnishing us with the much-desired anatomic basis for this remarkable difference, so strikingly shown in the course of laparotomy under local anæsthesia. If post-operative adhesions are oftentimes unavoidable, let us, therefore, in the light of these observations, strive to limit their formation to the viscero-

visceral, rather than the visceroparietal variety, for the double reason that the former are not only painless but, generally speaking, far less dangerous.

One of its most striking characteristics is the rapidity with which the peritoneum can form adhesions—a piece of gauze introduced into the abdomen during the course of an operation becoming quite snugly fixed to the visceral surfaces within a period of twenty minutes; a fact that is daily taken practical advantage of by surgeons in the disposition of protective gauzes during operations upon infected areas, and which adds materially to the sense of security afforded by gauze pads alone. This characteristic is also very intimately involved in the whole question of peritoneal drainage; and it constitutes further one of nature's admirable methods of protection against disastrous peritoneal damage, as exemplified in the walling off of an appendix abscess.

Finally, perhaps less striking but to my mind even more remarkable, is the completeness with which the peritoneum may absorb adhesions, and, indeed, completely eradicate all traces that would indicate their previous existence. I am convinced that it is a perfectly safe assertion to make that adhesions invariably follow laparotomy, and yet how common it is nowadays to find at a later second laparotomy no traces of them whatever.

Now, obviously, all of these fundamental and important characteristics of the peritoneum must be reckoned with in studying the process of adhesion formation and in any attempt to control or prevent it. Happily we now know, as a result of much careful experimental and clinical study, quite accurately the pathological changes involved. Wegner,¹⁰ in 1877, made a lengthy report of elaborate researches into the histological changes occurring in the peritoneal endothelium under a variety of experimental conditions. One rather unique experiment of his was to blow air into the peritoneal cavities of rabbits over a period of one month, observing the effects after varying intervals of time. He found fatty changes in the endothelium after four days, which later—after eight or

ten days—changed to scar tissue, but produced no adhesions. Graser²⁰ described in detail, with illustrations, the early histological changes occurring in aseptic wound healing of the peritoneum. He showed that after injury to the endothelium, the denuded surfaces lie together by reason of the agglutinating properties of the exudate, which later, through the growth of spindle-cells, becomes changed into vascularized connective tissue, and terminates in the parts becoming grown fast together. More recently Hertzler²¹ published observations on the formation of peritoneal adhesions made in a rather novel way, namely, through a small glass window sewed into the abdominal wall of the animal. He concluded that peritoneal surfaces may agglutinate without destruction of the endothelial layer; but that in true adhesions the endothelium is always destroyed. If, however, the basement membrane is not destroyed also, he believes that the adhesions may later separate; otherwise, the union is rendered permanent through the formation of fibrous tissue. It would seem, therefore, that the pathological changes involved in the process of adhesion formation in the peritoneal cavity are, in order of sequence: (1) injury or death of the surface endothelium; (2) pouring out of coagulable exudate; (3) agglutination; (4) organization; (5) fibrous tissue formation, which terminates ultimately in (6) a contracted scar. Observe that the whole process is dependent upon and subsequent to injury to the surface endothelium.

It is not surprising, then, to find the bulk of the literature on the etiology of adhesions concerned with a study of the various agencies ordinarily coming in contact with the peritoneum that might be considered inimical to the vitality of its endothelium. For the sake of brevity and clearness we may classify these contributions according to subject-matter as follows: (1) blood; (2) sutures and ligatures; (3) eschar of the thermocautery; (4) air; (5) infection; (6) mechanical, chemical and other agents.

Blood.—The final verdict has not yet been given regarding the relationship of free blood in the peritoneal cavity to ad-

hesion formation. Penzoldt²² published, in 1876, the results of a very elaborate experimental research into the fate of large amounts of blood in the peritoneal cavity, showing that it is absorbed. Wegner¹⁹, in 1877, and later Vogel²³ observed the same thing experimentally. V. Dembowski²⁴, in 1888, reported the results of a large number of carefully executed experiments on adhesion formation in the peritoneal cavity, and concluded with reference to blood-clots, that they do not provoke adhesions. Gersuny²⁵, on the other hand, after studying a group of cases exhibiting a constant type of adhesion about the sigmoid ("flexur adhesion"), thinks that bleeding from ovulation or tubal menstruation may be the cause. Zweifel²⁶ and his school—*vid.* Füth²⁷—strongly advise the removal of all blood from the peritoneal cavity in cases of ruptured ectopic pregnancy. Fromme²⁸ reported, a few years ago, the results of very elaborate and painstaking experiments on rabbits designed to test, (1) the effect of blood alone, and with serous defects in the peritoneal cavity; and (2) of infected blood alone, and with serous defects; using for this test pure cultures of common bacteria. He concluded that in the vast majority of cases neither blood alone nor with peritoneal defects produces adhesions. Furthermore, some of the cases with infection added showed none, although the majority of these did develop adhesions, especially those with raw peritoneal surfaces. Fromme quotes Biyl as having reached the same conclusions experimentally a few years before. Flateau²⁹ opposes the views of Zweifel's school, and leaves all the blood in the peritoneal cavity in cases of ruptured extra-uterine pregnancy that does not escape as a result of necessary operative manipulations. He condemns all efforts to remove it on the ground that it is impossible to get it all out, and that attempts to do so only serve to prolong the operation and to injure the peritoneum. Baisch³⁰, on the basis of his experimental work, concurs with the view that the peritoneum is capable of absorbing large amounts of blood without resulting adhesions, if intact, but finds that whenever a serosa-free surface is present it always leads to adhesions.

My own experience leads me to believe that the blood originating from rupture or abortion in cases of ectopic pregnancy does not produce peritoneal adhesions. The pelvic adhesions so commonly found in these cases are to be explained much more rationally, it seems to me, on the probability of associated or pre-existing infection, or as attributable to irritation induced by the development of the gestation sac. I have frequently observed cases in which the abdomen had been filled with a mixture of blood and serous exudate for periods of twenty-four hours or longer, and yet at operation it was seen that the peritoneum had not even lost its gloss. It is my deliberate judgment, therefore, that blood alone does not cause peritoneal adhesions, but that when it is associated with infection or trauma, its presence is to be regarded as an adjuvant to their formation.

Sutures and Ligatures.—The ultimate fate of aseptic sutures and ligatures in the peritoneal cavity and their relationship to adhesion formation have been carefully studied by a number of workers. Hallwachs³¹, in 1879, showed with good experimental work that non-absorbable sterile ligatures in the peritoneal cavity first produce a circumscribed inflammatory reaction, then become covered with a thin layer of granulation tissue, and being thus isolated from surrounding structures, become gradually disintegrated and are removed through the agency of the tissue juices and leucocytes. Spiegelberg and Waldeyer³² had earlier, in 1868, noted the harmlessness of aseptic ligature material in the abdomen. Rosenberger,³³ Tillmans,³⁴ tenBrink,³⁵ Kelterborn³⁶ and others later confirmed these observations. V. Dembowski,²⁴ on the contrary, concluded from his experiments that all sutures act as foreign bodies and cause firm adhesions along their lines of insertion; but his work was not convincing to later investigators. Stimson,³⁷ in 1889, called attention to the dangers of mass ligatures, and recommended substituting individual ligation of vessels in pedicles, and covering the latter with peritoneum. Klotz³⁸ found in six cases relaparotomized for ileus each time a loop of small bowel adherent to a pedicle stump. I

recall very distinctly a case of post-operative ileus, observed a few years ago during my hospital apprenticeship in the department of Dr. H. A. Kelly at Johns Hopkins Hospital. A simple interval appendectomy had been done by one of the members of the House Staff. The usual technic of the department had been employed—i.e., amputation by the clamp and cautery method, inversion of the stump, and securely tying a purse-string suture previously placed about the base. Only, in this instance, owing to the insignificant size of the meso-appendix pedicle stump, the usual custom of covering it over had been omitted. At the second operation, performed within forty-eight hours, I found a band of omentum quite snugly fixed to this little mesenteric stump and obstructing the ileum. Rubin³⁹, in his report of an elaborate pathological and experimental study of the functions of the great omentum, published only a few months ago, concluded, with reference to omental adhesions to the abdominal incision, that they are best prevented through a carefully introduced continuous catgut suture. Neuhof and Wiener⁴⁰ also very recently published the results of a most interesting and instructive experimental study of omental adhesions. They showed that the omentum is capable of insinuating itself into needle punctures, and through the small gaps between peritoneal sutures, and of adhering to these minute raw surfaces. It is obvious how easy it would be for a less careful observer to attribute such findings to the presence of the suture itself. It seems to me definitely proven, then, that when one exercises good surgical judgment in the choice of aseptic sutures and ligatures, and manual dexterity in their application, together with proper attention to covering up pedicle stumps, no grave fears need be entertained as to troublesome adhesions arising from this source.

Eschar of the Thermocautery.—The results of the experimental work on the use of the thermocautery in the peritoneal cavity have been somewhat conflicting. Thus Spiegelberg and Waldeyer,³² v. Dembowski,²⁴ Franz,⁴¹ and Maslowski⁴² found that it produces adhesions. Baisch⁵⁰ and Kelter-

born,⁸⁶ on the other hand, were unable to confirm this work. TenBrink⁸⁵ produced adhesions with the cautery only when infection was present. Küstner⁴³ reports in detail a case in which a large ovarian cyst, with many pelvic adhesions, was removed, the actual cautery being used to sever the adhesions and also the pedicle of the cyst. At a second operation fourteen months later for post-operative hernia no adhesions were found where the cautery had been used. A possible explanation of these conflicting reports is to be found in Vogel's²³ excellent monograph. He found that a superficial burning of the peritoneum generally gives rise to adhesions, but that none occur after a thorough cauterization with the formation of a thick eschar. As long ago as 1877, Wegner¹⁹ explained the formation of peritoneal adhesions as analogous to healing by first intention, and Vogel, with this idea in mind, ascribes their failure to materialize, after a deep eschar or a severe chemical injury is produced, to the fact that the layer of necrotic tissue prevents primary union; or, in other words, the charred surface protects the underlying granulations from contact with neighboring structures long enough for them to become covered with new endothelium. Webster⁴⁴ corroborates Vogel's claims, and advocates very thorough cauterization to produce a black char. Whether or not this explanation is correct, the weight of experimental and clinical evidence certainly warrants the thorough application of the cautery when indicated, with far less likelihood of adhesions ensuing than if certain other procedures applicable to the same conditions are substituted.

Air.—Exposure of the viscera to the air is recognized, of course, as one of the cardinal factors in the production of surgical shock. It may not be so generally known, however, that very elaborate and interesting experiments have been carried out to ascertain the exact effect of air on the peritoneal endothelium and its relation to adhesion formation. Reference has already been made to Wegner's unique experiment of blowing air into the peritoneal cavities of rabbits over

varying periods of time, thereby producing decided changes in the surface endothelium, even to complete substitution by scar tissue, but observing no signs of adhesions develop. Walthard's⁴⁵ experiments have been much quoted in this connection, because of the great care and thoroughness with which they were conducted. No one can read this communication without being impressed by these facts, as well as by the significance of his conclusions. In his first series of experiments he performed supravaginal hysterectomy on a number of rabbits, carefully avoiding mechanical injury to the peritoneum of the uterovesical pouch by not touching it at all; he freely exposed it to the air, however, and at the autopsies, some days later, he found adhesions in every case between the surfaces of the uterovesical peritoneum. In the next series he brought the uterus out through a laparotomy wound, and very carefully protected it, as well as the surrounding parts, with gauze pads moistened with hot salt solution; he kept the moisture, temperature, and protection as nearly constant as possible. At the end of the experiment the uterus was returned to the peritoneal cavity and the wound closed. Later post-mortem examinations showed no adhesions and no exudate in any case. Next he tested in cats the effect of air contact on isolated areas, by exposing a loop of bowel, part of the omentum, or the posterior part of the bladder peritoneum to the air for twenty minutes. Twelve days later at autopsy every case showed adhesions between the bladder peritoneum, omentum, and incision. The intestine, however, did not adhere in any of these animals. In an equal number of control animals, protected with moist hot gauze, no adhesions occurred. In a very ingenious way he then exposed the peritoneum to air filtered free of dust and infection, and found that adhesions resulted under absolutely aseptic conditions. He then tested the effect of steam at 38° C. on the peritoneum and found that it produced no adhesions. Next he tested the chemical action of component parts of the air (O—CO₂—N) and found that none of them produced adhesions, if moisture was present. Dry air at 38° C.

produced both adhesions and macroscopical changes in the peritoneum. He concluded from these results that the damaging influence of air on the peritoneum is not dependent upon the presence of dust and infection, but when freed from these and in a state of dryness, its prolonged contact with the normal serosa produces a necrosis of its endothelium by cooling, with resulting contraction of the blood-vessels and consequent diminished nutrition, leading finally to adhesion formation. He believes, further, that long exposure to air lowers the resistance of the peritoneum, so that the number of bacteria necessary to produce fatal peritonitis is greatly reduced. His experimental deductions are borne out clinically in 146 laparotomies on human beings for various causes, in that not only no adhesions clinically discoverable occurred, but also much less post-operative flatulence was seen. The year following Walthard's publication Schiffer⁴⁶ reported from Sanger's clinic a marked falling off of ileus cases following the introduction of moist asepsis. In 132 laparotomies with dry asepsis, there were 10 deaths, 5 of which were due to intestinal obstruction. In 76 cases with moist asepsis there were 2 deaths—both cases of ruptured ectopic pregnancy—and no ileus. He further noted much less post-operative discomfort, vomiting, and thirst. A few years later Uhlmann's⁴⁷ paper appeared based upon a very careful study of the material of Zweifel's clinic, and contradicting every essential point claimed by Walthard and Schiffer. Thus flatus was passed on the second day by both the dry and wet aseptic cases. Likewise the bowels moved on the third day alike in both classes of cases. Only one fatality from ileus occurred in 481 laparotomy cases with dry asepsis, although 18 (3.3 per cent.) of these did have intestinal disturbance; while in 80 cases with moist asepsis, 4 (5 per cent.) had severe intestinal disturbance. Operative peritonitis with death occurred in 0.6 per cent. of the cases during the period of dry asepsis and 1.25 per cent. during that of moist asepsis. Flatus passed and the bowels moved within the same period of time both in those cases which were eventrated

at operation, and those in which the intestines were left *in situ*—a fact which the author thinks casts doubt on Walthard's idea of deleterious effect of the air drying the peritoneum. In 23 cases relaparotomized—some of whose first operations had been done with antiseptic, some with dry aseptic, and some with moist aseptic technic—post-operative adhesions were found, but were always to be accounted for by trauma, and nowhere were adhesions found between two serous surfaces entirely uninjured at the first operation. Adhesions between loops of bowel were not more frequently encountered in the cases that had been everted than in the others of the relaparotomized series; a fact which the author thinks disposes of Walthard's idea of air damage. Furthermore, no connective-tissue thickening of the serosa was found in places where the surfaces were damaged at the first operation, but did not lie in contact long enough to adhere, and Uhlmann thinks that this does not occur when only the endothelium is injured. Although adhesions were found in all of the 28 cases relaparotomized, only 6 of these had shown intestinal disturbances—a fact which the author thinks shows how inaccurate the test of intestinal obstruction is as an index of the frequency of adhesions following any special operative procedure. He finds support of his criticism of Walthard's ideas in Fritch's⁴⁸ report of 52 laparotomies conducted with moist warm aseptic technic, furnishing two cases of ileus with one fatality, and concludes that the claims of Walthard and Schiffer are not proven, and should be tested further before the older methods are abandoned.

Now, in drawing conclusions from these reports as to the relative value of moist and dry asepsis, it must not be forgotten that nothing brought out in this clinical study of Uhlmann's invalidates in the least the experimental results of Walthard. It is of fundamental importance, too, to remember that the formation of post-operative adhesions does not depend solely upon the principles of technic involved respectively in moist and dry asepsis. Before a just comparison can be made clinically of results obtained by the two methods, there-

fore, it becomes necessary to exclude absolutely all other factors involved in the production of adhesions. It is manifestly illogical to throw together two heterogeneous groups of cases that have been laparotomized for a variety of conditions, and to ascribe the resulting difference in adhesion incidence solely to the factors involved in dry and moist asepsis. Such studies as those of Schiffer, Fritch, and Uhlmann, therefore, while furnishing most interesting and instructive data, are of very little value in determining the point at issue; and it seems to me that Walthard's experimental results render it imperative that surgeons should employ moist asepsis as far as practicable in the abdomen, at least until they are more successfully assailed than by the criticisms thus far brought forward. Thus, aside from shock, we have an additional very important reason for carefully protecting all parts of the peritoneum from undue exposure during the course of abdominal operations, namely the prevention of adhesions.

Infection.—No one doubts, of course, that infection produces adhesions. But there seems to be much difference of opinion as to the formation of adhesions without infection. Martin⁴⁹, as far back as 1888, made an exhaustive study of a series of cases requiring relaparotomy, and called attention to the increased difficulties of the second operation on account of intestinal adhesions to the anterior abdominal wall so commonly encountered. A number of observers—v. Velits,⁵⁰ Koblanck,⁵¹ Huth,⁵² Pernhorst,⁵³ Steffens,⁵⁴ and others—have since called attention to the gradual falling off in the number of adhesion cases seen in the clinics corresponding with the improvement in surgical technic. Some have interpreted the remaining incidence, however, as conclusive evidence that our methods are still imperfect as regards asepsis. Steffens's excellent contribution, based on a very thorough study of 45 patients relaparotomized, is worthy of more than passing notice. He found that more or less general adhesions were encountered at the second laparotomy in every case that had exhibited an elevation of temperature following the first operation. Pernhorst also noticed this fact, and thinks that

post-operative elevation of temperature is an indication of adhesion formation. Fritsch⁴⁸ showed from a study of re-laparotomized patients that adhesions occur in spite of the most careful technic. Reichel⁵⁵ concluded from an elaborate experimental, clinical, and bacteriological study of ileus that infection is the chief cause of this condition, and that it may produce very few clinical symptoms, and little or no change in the peritoneal surface. He thinks that the infection may be limited to one loop of bowel, and that the resulting interference with peristalsis is the chief cause of adhesions. Kelterborn's experiments led him to believe that peritoneal adhesions are due to infection always. V. Braun-Fernwald⁵⁶ and also Jes-set⁵⁷ later came to the same conclusion. The year following Kelterborn's report, Thompson⁵⁸ published the results of a large number of experiments on cats, dogs, and rabbits, carried out with the most elaborate precautions against all possible sources of infection, even going so far as to sterilize the air of the operating room. He found that omental and intestinal adhesions follow perfectly aseptic laparotomies, even when the abdominal wound is shown to be sterile. Fromme believed, from his very creditable experimental work, that peritoneal adhesions are due chiefly to infection, but that they can occur without it. The work of the several investigators referred to in the last section is in full accord with this idea. It is evident, therefore, that the alignment can be sharply drawn between the adherents of two views: (1) those who hold that infection is the sole cause of peritoneal adhesions; and (2) those who believe infection to be a frequent cause, but contend that adhesions will also result from a variety of other causes acting independently or collectively. To my mind the evidence given above establishes beyond doubt the correctness of the latter view.

Mechanical, Chemical and Other Agents.—During the period of transition from antiseptic to aseptic surgical technic, considerable discussion is to be found in the literature regarding the relationship of the former to adhesion formation in the peritoneal cavity. V. Dembowski⁵⁹ claimed to have in-

jected strongly irritating substances, *e.g.*, turpentine, into the abdomen without producing adhesions. He was also unable to produce them by such violent mechanical irritation as rubbing the peritoneal surface with a stiff tooth-brush; and even after deliberately excising islands of peritoneum together with the underlying fascia, he caused no adhesions. The omentum was adherent to the abdominal scar, however, in all of his animals; and he found, further, that gauze or other foreign bodies, introduced into the peritoneal cavity, always produced adhesions. Delbet, Grandmaison and Bresset,⁸⁰ on the other hand, published in 1891 the results of experiments which demonstrate very clearly the harmfulness to the peritoneum of such antiseptic solutions as carbolic and salicylic acids, bichloride and biniodide of mercury, and that they predispose to adhesion formation through their irritative action. Iodoform and salol, they found, have very little irritating effect. Klotz⁸⁸ reported a decided falling off in the number of post-operative ileus cases following the substitution of aseptic for antiseptic technic. Thompson⁵⁸ found that sterile foreign bodies, such as gauze, cause adhesions in the peritoneal cavity, if large enough to cause irritation. Tinker⁶¹ recognizes gauze drains and packs as common offenders in producing adhesions. Pankow,⁶² in testing the relationship of denuded peritoneal surfaces to adhesion formation, was able to produce adhesions in only one-half of his cases by stripping the parietal peritoneum sufficiently deep to cause multiple punctiform hemorrhages. Franz found no adhesions following aseptic peritoneal defects. Sanger⁶³ concluded, from operations in which portions of the parietal peritoneum were resected, that one wound surface is sufficient to produce adhesions, which inevitably follow, and that it is not necessary for two such areas to lie together for their formation. Klotz⁸⁸ states that post-operative ileus develops if an epithelial-free bowel surface, either through direct or indirect misplacement, lies in contact with a wound surface; and that the formation of adhesions is favored by the presence of blood. Rissmann⁶⁴ concluded from experiments on cats, dogs, and

rabbits that many adhesions occur accidentally in experimental work which are not intended; he differentiates seroserosous adhesions, which form without sepsis, chemical or mechanical irritation, from the dense union caused by local infection, possibly through chemical or mechanical irritation, and surely through apposition of the bared subperitoneal connective-tissue layer with the normal peritoneum. He considers that the first type are easily loosened, but that the latter remain much longer, their exact duration not being known. Neuhof and Wiener⁴⁰ found that under aseptic conditions the intact omentum always adheres to foreign bodies and to raw surfaces within its reach, whether parietal or visceral; that it always adheres by its free edge; that when resected it always adheres by the remaining intact edge; that a raw omental margin may adhere a certain length of time—possibly a week—after resection of the edge, and that such adhesions occur independently of peritoneal denudations or of foreign bodies; and that when infection is present not only the edge but the surface of the omentum becomes broadly attached by a thick exudate, even when the edge has been excised. Rubin's³⁹ exhaustive study of the function of the great omentum, already referred to, brought out some interesting factors involved in adhesion formation usually not mentioned in this connection. Thus he reminds us that the omentum possesses no spontaneous motility, and that its displacements are to be explained by: (a) intestinal peristalsis; (b) intra-abdominal tension; (c) static condition of the stomach, colon, and small bowel; and (d) its anatomical relationship to the gall-bladder and spleen. Further, that it possesses no demonstrable chemotaxis; the phenomena usually attributed to this property being in reality due to the presence of intraperitoneal fluid, gas in the large bowel, or the suction action of the diaphragm. And that its value in inflammatory conditions depends upon its power to form adhesions which isolate and render innocuous toxic products through absorption and elimination, or destroy them through the agency of its phagocytic elements. Ward⁶⁸ in his unusually clear and scholarly review summarizes his

views with reference to the etiology of peritoneal adhesions as follows: "We may lay down the statement that the formation of peritoneal adhesions after operation is directly proportional to the amount of sepsis, traumatism, dry air contact, loss of heat, and raw surface there is present." It is evident, therefore, that abundant experimental proof is available to support the generally accepted view that raw surfaces and other less severe injuries resulting from direct mechanical insult to the peritoneum furnish one of the commonest, if not the most frequent, causes of adhesions. In this connection, moreover, too much emphasis cannot be given to the importance of exercising the utmost care and gentleness in all intra-peritoneal manipulations. Rough handling of the viscera; unintelligent, and I might say sometimes almost brutal, use of retractors and other instruments; mauling the bowel surface by the introduction of innumerable gauze pads, which, to be sure, add materially to the comfort of the operator, but more to the distress of the patient; the application of dry gauzes to the peritoneal surfaces, which generally adhere and when removed often bring away with them the surface endothelium; unnecessary sponging, as a sort of surgical tic or habit-spasm; careless application of hæmostats, with painful indifference to the mass of crushed tissue left to necrose in the grip of the ligature—all of these constitute transgressions of which few of us can claim innocence. But they also constitute a prolific source of adhesions, and should, therefore, be constantly borne in mind, in order to impress upon ourselves the value and importance of diligently cultivating a healthy aversion to unnecessary trauma, and a profound respect for the tissues.

In the beginning of this paper I ventured to predict that peritoneal adhesions will of necessity always remain an inevitable part of abdominal surgery. I wish here to call attention to the fact that the soundness of the reasoning adduced in support of this proposition has been clearly established through the cumulative evidence that has steadily accrued in support of it throughout the detailed discussion of this whole subject. I stated, further, that it will be found in the last analysis

that in the intelligent management of peritoneal adhesions, the abdominal surgeon has recourse to three classes of procedures, namely, (1) measures which prevent adhesions; (2) measures which restrict their formation to the harmless variety; and (3) measures which aid in their absorption. Now it will become apparent from the following consideration of the prevention and treatment of adhesions to which of these classes each procedure thus far suggested belongs.

In the first place, certain prophylactic measures at once suggest themselves as being clearly indicated from what has already been said. Briefly stated, these are: rigid asepsis; avoidance of mechanical, chemical, or thermic trauma; careful covering over of all denuded surfaces; use of moist hot gauze; avoiding exposure of the peritoneum to air. Thus far practically everyone is agreed. But the common experience that troublesome and dangerous adhesions still quite frequently occur, in spite of the strictest possible observance of these measures, has led investigators to undertake the most varied and elaborate researches with the hope of discovering some prophylactic or remedial agent that would prove efficacious in all cases. As I have already pointed out, this is a vain hope, and such efforts are fundamentally wrong. Nevertheless, this work has resulted in the production of many ingenious and valuable procedures, all of which have at one time or another been enthusiastically advocated, and have received varying degrees of support from the profession generally. The reports of these heterogeneous devices can be conveniently grouped and discussed as follows:

Non-absorbable Protective Membranes.—From time to time investigators have attempted to prevent adhesions to raw surfaces by covering them over with films of some foreign substance that would serve as a protective membrane and that could be kept in position until the endothelium had regenerated. Thus Stern,⁶⁶ in 1889, experimented with collodion for this purpose; he warmly recommended it for covering pedicle stumps, but otherwise was unsuccessful with it. Wright⁶⁷ used a gelatin-formalin coagulum; his technic was

to cover oozing surfaces with a 15 per cent.-20 per cent. solution of gelatin, to which 1 per cent.-2 per cent. formalin was added; this caused the gelatin to form a coagulum in a short time, and to become fixed to the raw surface. Its use has not met with general favor, however. Morris⁶⁸ claimed from his experiments on rabbits that he found aristol to be insoluble in serous fluids, and that when dusted over raw surfaces it quickly forms a protective covering, with the aid of the coagulated lymph, which cannot be brushed off. He strongly advocated this lymph-aristol coagulum as a valuable anti-adhesion measure. Ellis⁶⁹ tested this idea on dogs with a number of different substances, including silver-foil; formalin-gelatin mixture; solutions of gutta-percha in (a) chloroform, (b) carbon bisulphide, (c) xylol; and thin sheets of collodion, sterilized and hardened in bichloride of mercury. He reported failures with all of these substances, except the last, and regarded it as impracticable for use in the abdomen, because it cannot be held in position. It is very evident from the reports that none of these substances can be relied upon to furnish more than a small percentage of successful results, and, on this account, cannot be recommended for general use.

Manual and Postural Arrangement of the Viscera.—This is accomplished partly through proper disposal of the viscera with reference to normal anatomical relationship, at the end of the operation, and partly through post-operative posture in the ward, with the double idea of avoiding permanent kinks at those parts of the gastro-intestinal tract which are known to cause trouble, and for the further purpose of preventing contact with raw surfaces by gravitating the abdominal contents away from them. Tinker,⁶¹ in a paper replete with practical suggestions, in addition to the commonly accepted procedures, emphasizes the thorough ante-operative evacuation of the bowels; post-operative posture to gravitate the abdominal contents away from raw surfaces for four or five days; avoidance of flatulence by stimulating peristalsis with strychnine and eserine; restricted and easily digested food; intestinal antiseptics; the importance of withholding mor-

phine; the employment of stupes and enemata; and getting patients out of bed early. Clark⁷⁰ reminds us, in a very forceful contribution, that certain anatomical considerations are of fundamental importance in connection with the problem of peritoneal adhesions. Thus he condemns the use of the omentum for the prevention of adhesions when it will thereby fix or drag down the stomach or transverse colon; because it causes gastric disturbance in the former event, and obstinate constipation in the latter. He further points out those movable parts of the gastro-intestinal canal that commonly produce untoward symptoms, if permanently kinked—especially the pylorus, duodenum, upper jejunum, pelvic loop of the ileum, cæcum, transverse colon, and sigmoid; and enjoins care in replacing the viscera in their proper relationship, especially where ptosis exists. Finally, he recommends the routine use of large enemata of hot salt solution at the end of abdominal operations, in order to fill the colon; which not only adjusts the latter properly, but further serves as an internal hot water bag applied directly to the sympathetic nervous system and great vessels, thus preventing shock, tympanites and adhesions, as well as stimulating the kidneys.

It seems to me that this idea of manual and postural arrangement of the viscera according to normal anatomical relationship is worthy of especial emphasis. Not only should it be employed as a routine measure, but it applies with particular fitness to that large group of cases in which we have no hope of successfully and completely preventing adhesions, and where, therefore, our choicest alternative is to restrict them to the harmless variety. Every surgeon is longing for some discovery that will dispel the dread and reluctance with which he approaches those miserable unfortunates, seen in every clinic, whose abdominal walls look like a patch-quilt from the scars of numerous laparotomies, who possess no vestige of endothelium on their parietal peritoneum, and whose viscera seem hopelessly entangled in an interminable meshwork of adhesions. We reluctantly add another scar; we painfully and aimlessly dissect in various directions from whatever

starting point our incision affords; and this we continue until the patient's collapse forces us to desist, when we gloomily close the abdomen, conscious of two things: namely, that we have not helped the patient, and that the same performance will, ere long, have to be repeated either by ourselves or some unfortunate colleague. Now would it not be wiser to study the situation a little more closely beforehand, especially from the anatomical stand-point to which Clark has drawn attention, and to determine clinically, if possible, which zone of adhesions is responsible for the chief trouble; then to assemble our most trustworthy methods, and to concentrate our operative attack upon an intelligent effort to restore normal anatomical relationship, and to restrict such adhesions as must of necessity follow to areas where they will either aid in the accomplishment of this purpose or else can do no harm?

Peristalsis.—Considerable work has been done on the early post-operative administration of various cathartics, with the idea of stimulating strong peristalsis, and thus liberating early adhesions as well as preventing their recurrence through constant motility of the bowel. Klotz⁸⁸ reports successful results in treating acute post-operative obstruction by gastric lavage with four to six quarts of warm salt solution, followed by the introduction of one and one-half to two ounces of castor oil through the stomach tube. He considers it useful only in obstruction from fresh adhesions. Cumston⁷¹ recommends, in a clinical lecture on adhesions, the hypodermic administration of physostygmmin for several days following laparotomy, with the idea of constantly changing the peritoneal surfaces in contact through peristalsis. Byford⁷² and Paton⁷³ also recommend early catharsis with the same idea in view. Vogel²³ obtained a fair measure of success experimentally with physostygmmin as an anti-adhesion measure. V. Hippel⁷⁴ considers this drug a valuable post-operative agent in preventing adhesions and ileus and recommends it highly. Busch and Bibergeil,⁷⁵ on the contrary, found experimentally that this drug is not efficacious in preventing adhesions. Uyeno⁷⁶ saw no effect on adhesions experimentally

produced in rabbits by irritants (iodine, and dilute acid, and alcohol) from the use of phyostygmmin. But systematic massage effected degeneration and absorption of them in most cases, leaving the intestinal coils free from each other. Conflicting opinions appear to be held, therefore, with reference to the value of early stimulation of peristalsis as a prophylactic measure against adhesions. It seems to me that it can scarcely be recommended as a routine procedure, but that in properly selected cases, dependent upon a number of obvious considerations, it is of distinct value.

Specific Drugs.—Already some observers have attempted to deal with peritoneal adhesions through the specific action of certain drugs in the body. Eastman⁷⁷ recommends the administration of iodides, in the form of the syrup of hydriodic acid, claiming that it inhibits the proliferation of connective tissue and aids in the absorption of adhesions. Thiosinamine, and its combination with salicylate of sodium, known as fibrolysin, have been accredited with possessing a softening influence upon cicatrices, and other abnormal growths of connective tissue. Offergeld,⁷⁸ with a full review of the literature, reports only failures in the treatment of peritoneal adhesions with this drug, after giving it a thorough trial, with close observations, in 55 cases. Busch and Bibergeil⁷⁶ tried the introduction of fibrolysin dissolved in salt solution directly into the peritoneal cavity, but found that it was absorbed too rapidly to be of any noticeable value. Michael,⁷⁹ on the other hand, reports most favorable results in the treatment of two cases of perigastric adhesions with it. Sidorenko⁸⁰ has just reported the results of a clinical, experimental, and histological study of fibrolysin on cicatricial tissue. From a critical study of the results of other workers, and from his own results, he concludes that it does not exert any therapeutic effect upon cicatricial tissue. Hertzler²¹ tried to diminish the coagulability of the blood, with the idea of preventing agglutination through the transformation of the exuded serum into fibrin—the first essential stage in adhesion formation. He used (a) phosphorus by mouth, because it destroys fibrinogen and thus

prevents coagulation; and (b) peptone hypodermically, because it neutralizes the fibrin ferment in the blood. He claims absolute success with phosphorus. Marvel⁸¹ recommended introducing adrenalin into the peritoneal cavity in warm salt solution to prevent adhesions, claiming that it dissolves the peritoneal exudate and thus aids in its absorption; and further, that it prevents subsequent exudation by stimulating vasoconstriction and thus shutting off leakage. It appears, therefore, that an encouraging measure of success has attended these pioneer efforts to apply specific chemotherapy to the problem of peritoneal adhesions, and it seems to me that further development along this line is to be confidently expected, inasmuch as the possibilities of this important field of research are just beginning to be recognized and to attract wide-spread attention.

Normal Salt Solution.—Large quantities of physiological salt solution poured into the abdomen at the end of the operation in order to float the loops of bowel into their normal relationship and to keep denuded surfaces separated was at one time extensively used. Müller,⁸² in 1886, was the first to recommend this measure, although Malcolm⁸³ independently advocated the same thing in 1890. Stern⁸⁶ concluded from his experiments that the formation of adhesions was not hindered by this procedure. Morris⁸⁸ came to the same conclusion, and explained the failure as being due to rapid absorption of the fluid. This view has since been abundantly corroborated, and there is no evidence to show that new growth of endothelium over raw surfaces occurs to any considerable extent before the fluid is absorbed and they are again in contact. Cumston⁸⁴ actively opposes its use not only for this reason, but also because he thinks this rapid repletion of the circulation is dangerous; that it causes the intestines to float in contact with raw surfaces; and that it pushes the diaphragm up, causing dyspnoea and pneumonia.

Gases.—Bainbridge⁸⁵ has recently advocated distending the abdomen with oxygen gas just prior to complete closure of the peritoneum, as a useful resuscitating and anti-adhesion

measure. Cleveland⁸⁶ suggests the employment of oxygen to inflate the intestines in order to prevent and relieve acute post-operative obstruction, with distention, vomiting, rapid pulse, and respiration. Quite recently also Gellhorn⁸⁷ has recommended with considerable enthusiasm the periodic induction of intra-abdominal hyperæmia by means of the local application of the hot-air bath to the lower trunk. Strumpel⁸⁸ reported last year quite a large series of major abdominal operations and hernias in which this measure was employed. It was applied for one and one-half hours, at three-hour intervals, during the first forty-eight hours, if necessary. He warmly recommends it as a part of the routine post-operative therapy, claiming that it stimulates early peristalsis, with the passage of flatus and fæces; that it improves the patient's condition; that it is a prophylactic measure against peritonitis and adhesions; and that where the former exists it aids in its cure and localization.

Eschar of the Thermocautery.—As already pointed out, if this measure is utilized, the cauterization should be very thorough, so as to produce a deep and lasting charring of the tissues. It undoubtedly possesses distinct advantages under certain conditions.

Lubricants.—Because of their harmlessness, ease of application, and apparent effectiveness in many cases, various oily and fatty substances are perhaps more extensively used than any other single artificial measure in the treatment of adhesions. A number of substances of this kind have been suggested from time to time and carefully studied experimentally. Morris⁶⁸ testifies that he saw Martin, of Berlin, in the eighties rubbing oil on raw peritoneal surfaces. He is generally accredited with being the first to employ this measure, although I have been unable to find any publication from him on the subject. Vogel²⁸ obtained some success in rabbits with a mucilage of gum arabic. Busch and Bibergeil⁷⁵ tested a number of substances—including lanolin, paraffin, olive oil, and agar—all of which irritated the peritoneum and favored adhesions; while gum arabic and gelatin were too rapidly absorbed

to be of value. Blake⁸⁹ concludes from a small number of experiments on cats that moderate quantities of olive oil (1-4 oz.) are not dangerous in the peritoneal cavities of animals; that it remains there 5-15 days; and that it tends to prevent adhesions to denuded or inflamed surfaces, but is not always effective. Gellhorn⁸⁷ experimented on dogs and rabbits, using liquid lanolin, but obtained only partial success. Claypool, Vance, Robertson, and Field⁹⁰ tested olive oil and liquid petrolatum on dogs. They concluded that the former tends to prevent adhesions, but that the latter is of little value. They found olive oil in the peritoneal cavity uniformly after three weeks in sufficient quantity to measure; sometimes also at the end of four weeks. They recommend sterilizing the olive oil at 115° C. for 15 minutes, which they think does not split off fatty acids that irritate the peritoneum. Wilkie⁹¹ also calls attention to the fact that the irritation of olive and other oils is due to the separation of fatty acids in the process of sterilization. He recommends vaseline oil—a liquid paraffin which comes to the surface in the preparation of vaseline—as being absolutely neutral and unchanged by sterilization. He strongly advocates its use in mopping over denuded surfaces in the peritoneal cavity. This class of substances seems undoubtedly to possess some merit as prophylactic agents against adhesions; and it is very probable that the presence of fatty acids set free during sterilization is responsible for some of the conflicting results obtained. I have had opportunity, however, to observe the ultimate effect of both olive and vaseline oils in one case of very extensive peritoneal adhesions. After the adhesions were released, I carefully applied sterile olive oil to all of the denuded surfaces before closing the abdomen. At a subsequent laparotomy for pernicious vomiting, about a year later, the adhesions were fully as wide-spread and dense as at the other operation. This time I substituted vaseline oil, which was applied with great care and thoroughness; but again within a year laparotomy became necessary, and there was no evidence whatever of benefit from the lubricant. I am indebted to Dr. H. A. Kelly for

the privilege of mentioning this case, which was seen in his department at the Johns Hopkins Hospital.

Non-viable Animal Membranes.—The so-called Cargile membrane, made from the peritoneum of the ox, a similar membrane made from the shark's peritoneum, goldbeaters skin, derived from the outer coats of the cæcum of the ox, and a finely woven cloth made of catgut constitute the members of this group. Cargile membrane has been more extensively used than any of these, due largely to the enthusiastic advocacy of it by Morris.⁹² He obtained the idea from Dr. Chas. H. Cargile, of Bentonville, Ark., and hence gave the membrane his name. Morris concluded from a small number of experiments on rabbits that the membrane resists absorption in the peritoneal cavity more than 10 and less than 30 days; that it causes temporary loose adhesions of a harmless kind, which are mostly absorbed in less than 30 days; that it causes very little disturbance, is not a good culture medium, protects raw surfaces until repair occurs, and remains in position without stay-sutures, if kept dry. In a later publication he admits failure with the membrane in some cases. He suggested substituting shark's peritoneum, because it is cheap and plentiful. Baum⁹³ justly claims priority in the discovery of the so-called Cargile membrane. In 1894 he published a brief report of experiments with catgut woven into cloth, fish-bladder, and peritoneum prepared from young calves freshly slaughtered. His results were encouraging, and he warmly recommended these substances for general use. Craig and Ellis⁹⁴ subjected the Baum (Cargile) membrane to a careful experimental and histological study. They showed that in the peritoneal cavity, both the chromicized and unchromicized varieties are of no value in preventing adhesions, but that, on the contrary, they act as foreign bodies, and promote adhesion formation. Stavely⁹⁵ reports a case laparotomized six times for adhesions, three of which operations he performed. He employed this membrane, but found at a subsequent laparotomy that it had failed. Lauenstein⁹⁶ used a silk protective to prevent adhesions about the gall-bladder in one case, but found it of no

practical value. Theoretically, it is surprising that these membranes do not uniformly provoke rather than prevent adhesions—and, as shown by the above citations, there is considerable evidence in support of this view—inasmuch as a piece of dead animal tissue that has been kept in preservative fluid, although it may later undergo absorption, is nothing more nor less than a true foreign body while it remains in the peritoneal cavity, and must be so regarded in its relations to adhesion formation. It seems to me inevitable, therefore, that these substances will gradually fall into disuse.

Viable Grafts.—Much more rational are the efforts to cover raw surfaces by plastic operations on the peritoneum, or with peritoneal or omental grafts, as will appear from the following reports. Senn⁹⁹ demonstrated experimentally, in 1888, that omental grafts 1–2 inches wide, and long enough to completely encircle the bowel, retain their vitality, become firmly adherent in 12–18 hours, and freely supplied with blood-vessels in 18–48 hours. Also that both the adhesions and the vascularization are hastened and improved by preliminary scarification of the serous surface and the graft. He recommended the use of such grafts in wounds of the gastro-intestinal canal, to reinforce circular enterorrhaphy, and to cover up peritoneal defects and pedicle stumps. V. Dembowski⁵⁹ the same year reported experiments which showed that if the omentum be sutured to the anterior abdominal wall, it becomes firmly adherent in 3–4 days, but that the intestine never adheres to it. Tietze⁹⁸ reported successful reinforcement experimentally of stomach and intestinal sutures by the application of parts of the attached omentum. His cases included three groups: (1) reinforcing experimentally produced necrotic areas in the stomach and intestinal walls; (2) reinforcing end-to-end intestinal anastomosis; (3) closure of stomach defects with plugs of omentum. Thompson⁵⁸ concluded that if the omentum be simply spread out behind the abdominal wound, it prevents the intestines becoming adherent to the latter. Webster⁴⁴ recommends, among other measures, covering raw surfaces with adjacent healthy peritoneum, and

also transplanting grafts of both peritoneum and omentum. Amann⁹⁹ advocates covering defects in the pelvis with movable peritoneal flaps, such as can be obtained from the anterior half of the pelvis. He also recommends mobilizing the sigmoid and suturing it to the uterus, or, if the latter is removed, to the bladder peritoneum, or to that of the pelvic brim, to prevent the small bowel falling into the pelvis and becoming adherent. Morris⁹² also employs the Senn omental graft. Loewy,¹⁰⁰ on the basis of his experimental work, recommends the employment of omental grafts in a number of conditions, and discusses several types that he has successfully used. Girgola¹⁰¹ recently carried out an interesting series of experiments on omental grafts in cats and dogs, successfully covering raw surfaces of the large bowel, bladder, and stomach, without adhesions to the graft and without failure of the latter. On the small bowel, however, the graft adhered either to adjacent loops of small bowel or to other structures. He injected the thoracic aorta 18-24-48 hours, and 3-5-7 and more days after the grafting with coloring matter, and even where the graft had formed no adhesions, except to the organ applied, he succeeded in thus injecting its capillaries in the surprisingly short period of 24 hours, and to a greater extent later on. Springer¹⁰² published last year the results of a careful experimental study of omental grafts in dogs. He found that if the entire free omentum be amputated and simply dropped into the abdomen, it does not necrose but becomes spread out, adheres to the parietal peritoneum, and becomes quickly vascularized. Further, that detached omental flaps sewed over considerable areas of the small bowel adhere, are rapidly vascularized, and are useful for covering raw surfaces without causing any narrowing of the lumen. But that such flaps always adhere extensively to neighboring loops of bowel; they do not compensate defects, but reinforce; they do not prevent adhesions, except on movable organs with strong peristalsis, like the stomach and urinary bladder; that they are good for reinforcing lateral and end-to-end anastomoses of hollow viscera; that omental stumps also become

adherent unless covered in, and that omental grafts may be used to cover peritoneal defects.

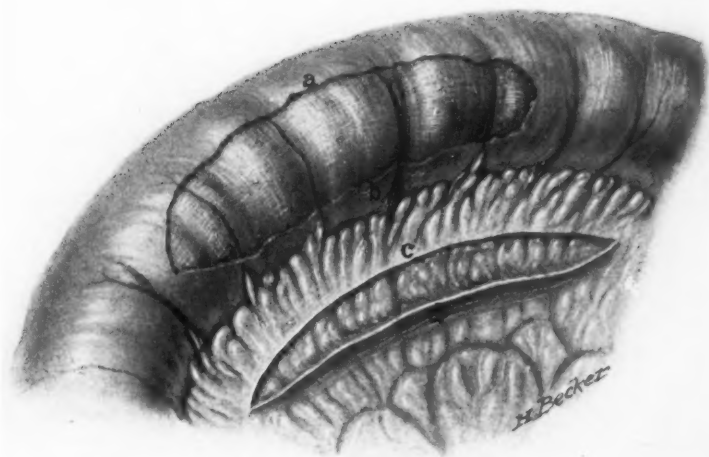
It is very evident, therefore, that grafts of fresh omentum and peritoneum have a very important and wide field of application in abdominal surgery, and that they constitute one of our most valuable prophylactic and controlling methods in dealing with adhesions. Autoplastic grafts are to be preferred, of course, but I am of the opinion that, with the exercise of proper precautions, homoplastic grafts might also often be advantageously used, at least in our larger clinics where abundant material is available. But the supply to be obtained even here would prove entirely insufficient for use in a case of generalized or universal peritoneal adhesions. These are the cases that baffle us, and that stubbornly resist any or all of the methods of treatment thus far suggested. I have already indicated the futility of repeatedly releasing these adhesions indiscriminately and in whatever direction seems to be easiest at the time of the operation, thus blindly dissecting without definite aim until the patient's collapse forbids our going further; and I pointed out, on the other hand, the wisdom of studying these cases more closely beforehand to determine clinically which area of adhesions are specifically responsible for the patient's symptoms. In the solution of this problem we will be greatly aided by bearing in mind especially those parts of the gastro-intestinal canal which are known to cause trouble when they become involved in adhesions and kinked. In the majority of instances one or more of these regions will be found to be our vantage point in the operative attack, and our effort should be to restore as near to normal as possible these parts. The method of procedure, then, is first of all an accurate diagnosis; next release the adhesions that are causing the trouble; then partly prevent and partly restrict their re-formation to the harmless variety by the judicious application of viable grafts of omentum or peritoneum—preferably autoplastic or homoplastic ones, but if these are not obtainable, use heteroplastic grafts of peritoneum, obtained from a freshly slaughtered calf under aseptic conditions just

prior to the operation, and carefully guarded from mechanical or chemical trauma—and by disposal and fixation, by suture if necessary, of the viscera according to normal anatomical relationship; so that whatever adhesions recur will aid in the accomplishment of our purpose. Such a course at least possesses the merits of being intelligent and feasible, and of saving the patient the added shock of a prolonged dissection through many square centimetres of viscerovisceral adhesions which are doing no harm, and which promptly re-form. These merits, to my mind, are sufficient to justify its adoption.

A NEW METHOD OF TREATING DENUDED BOWEL SURFACES.

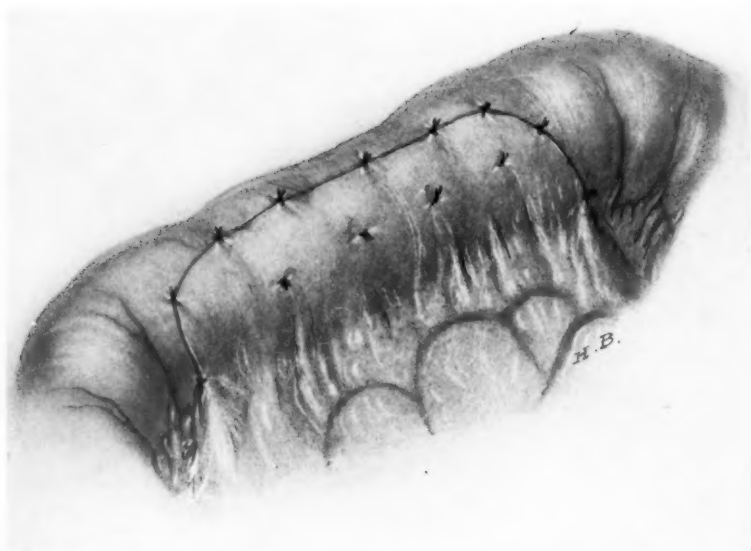
A few months ago, during the course of an operation for the relief of an enormous post-operative ventral hernia, a situation arose which suggested to me a new, and what I believed to be an eminently satisfactory, method of dealing with denuded bowel surfaces under certain conditions. The patient was a very large, fat woman, well past middle life, who by reason of circulatory and renal disease was rather a poor surgical risk. Moreover, about six months previously she had undergone a very serious operation for radical removal of the generative organs on account of a moderately advanced cancer of the uterine cervix, at which time the abdominal wound had evidently become infected and broken down, with a resulting hernia. Occupying the hernial sac, besides a bulky omentum densely adherent throughout, there was a long loop of ileum, coiled in a horse-shoe fashion, each limb of which had become so intimately adherent to the peritoneal lining of the sac as to render separation along any definite line of cleavage impossible. The two limbs were also adherent to each other by several transverse bands of dense fibrous tissue. After effecting the release of the intestine I had, therefore, two extensive raw areas, each measuring two to three inches in length, involving nearly one-half the circumference of the bowel, and separated from each other by six or eight inches of practically normal intestine.

FIG. 1.



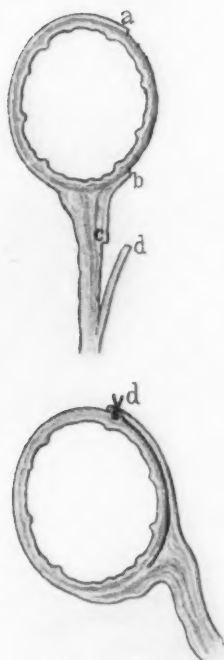
An extensive denuded area on the surface of the ileum is here shown. Observe that at its widest portion, *a-b*, it involves nearly half the circumference of the bowel. The liberal deposit of fat in the mesentery here represented admits of the ready separation of its two peritoneal leaves. Note that the incision for this purpose through the upper leaf is made about 1 cm. from its bowel attachment, in order to avoid the numerous branching vessels in this region. The separation of the flap *d* is now easily and safely effected to any desired extent, since the average width of the mesentery is eight inches. A flat, blunt instrument—a spatula, for example—is best suited for this step. The rich vascular anastomosis between the mesenteric leaves, afforded by the superimposed colonnade arrangement of the trunk vessels, is easily seen.

FIG. 2.



The detached flap of peritoneum is here shown drawn up over the raw bowel surface and firmly fixed by interrupted sutures of fine silk. Note how completely and satisfactorily the defect has been remedied. Observe too, that, owing to the mobility of both the bowel and its mesentery, the mechanical effect on the bowel lumen and the mesenteric circulation is negligible and cannot produce any serious consequences. Care must be taken to close the angles of the mesenteric flap just at the bowel margin as shown, to avoid the possibility of an intramesenteric hernia.

FIG. 3.



The bowel and its mesentery are here represented in cross-section. In the upper drawing, the area between *a* and *b* is the raw surface; *c* marks the point of incision through one peritoneal leaf of the mesentery; and *d* the flap to be freed and drawn up. The lower drawing shows the flap *d* closely applied over the denuded area, and fixed by sutures which should penetrate the submucosa.

FIG. 4.



The plication modification of the method is here shown. Owing to an almost total absence of fat between the peritoneal leaves of the mesentery in some cases, it is unsafe and impracticable to attempt their separation. In such cases *neither leaf is incised or separated from its bowel attachment*, but both leaves are grasped together at the proper distance from the bowel border, lifted over the raw surface, and fixed by silk sutures. It amounts to a plication of the mesentery or a partial envelopment of the bowel within both layers of its mesentery. Note that care has been taken to place the sutures between the vascular trunks. This simple modification renders the method applicable to all cases, is even more quickly executed, and is eminently safe and satisfactory.

Another factor of great surgical importance was the extensive dissection necessary to cure the hernia, by reason of the wide separation of the recti muscles, the enormous size of the opening, the abundant scar tissue produced by the old infection, and the atrophy and impaired vascularity of the tissues to be utilized in effecting the closure. These unfortunate circumstances, together with the patient's general condition, made it highly important that all possibility of wound infection should be scrupulously avoided, as well as that every possible precaution should be taken against the occurrence of intestinal obstruction, which might necessitate the undoing of all my work.

Now recalling the condition of the bowel surface just described, it is evident, upon consideration, that none of the customary methods of dealing with this complication were applicable to the conditions in hand. I could not, for example, invert the raw surfaces, because of their extent and proximity to each other—obstruction would almost certainly have ensued. The various other methods already described were either impracticable or too unreliable, in view of the serious consequences of failure. I did not dare resort to lateral anastomosis, because I was dealing with the lower ileum; and while this procedure would have taken care of the raw surfaces and obviated the danger of obstruction, it would at the same time have afforded an excellent opportunity for infection of the devitalized tissues of the wound, with complete destruction of all my plastic work and immediate recurrence of the hernia. Fortunately, the problem was practically solved for me by the accidental laceration and partial retraction of one leaflet of the mesenteric peritoneum just along the line of its attachment to the bowel, and adjacent to one of the raw areas on the surface of the latter, which occurred during its separation from the hernial sac (Fig. 1). There being a considerable deposit of fat between the two layers of mesenteric peritoneum, it was a surprisingly simple and easy procedure to extend the separation of the torn leaflet and its attached fat in all directions from the underlying vessels and the oppo-

site intact leaflet with its fat, thus obtaining a large, movable flap of normal peritoneum, which was easily drawn up without tension, spread out over the raw surface on the bowel, and tacked down with a few fine silk sutures (Fig. 2). The result was eminently satisfactory in every way, this very simple device, which was quickly carried out, having sufficed to abolish a rather complex and embarrassing surgical situation. The patient's recovery was complete, and she is now comfortable and happy.

This fortunate experience led me to investigate the idea further, in order to determine accurately its possibilities and limitations, and to meet certain theoretical objections.

Thus it was desirable to ascertain if the method could be applied to all portions of the intestinal tract; if the separation of the two peritoneal leaves of the mesentery could be rapidly effected, without injury to the vessels, in poorly nourished individuals whose mesentery usually contains very little fat; and if not, to consider the feasibility of lifting a fold of both leaves of the mesentery, without incising either, over the raw surfaces, thus effecting practically a plication of the mesentery—a modification of the method that would make it applicable to these cases also (Fig. 4); to determine further, what effect this axial rotation or partial envelopment of the bowel within its own mesentery would have on the calibre and direction of the lumen, with reference to obstruction; to investigate to what extent it would be practicable to so treat the bowel; to ascertain particularly what effect was produced on the mesenteric and bowel circulation by this mechanical alteration of normal conditions; and finally, how much tension the leaflet of peritoneum is capable of withstanding, with reference to its being torn loose by post-operative distention or vigorous peristalsis.

The fresh cadaver seemed to offer the best method of settling these questions, and my conclusions, based upon such a study, are as follows:

1. The procedure is best applicable to that portion of the intestinal tract where, in such cases as the one described,

present methods are inadequate, namely, from the upper jejunum to the lower ileum. It may be rationally applied, however, to any portion of the bowel possessing a mesentery of sufficient length to admit of its ready execution.

2. Care must be exercised at the duodenum, upper jejunum, and lower ileum not to produce kinks of the bowel.

3. In cases exhibiting a scanty deposit of fat in the mesentery, plication is a rapid, safe, and efficient substitute for separation of the two peritoneal leaves.

4. Aside from a slight spiral rotation, which in view of peristalsis and the mobility of the parts is entirely insufficient to produce obstruction, the procedure has no demonstrable effect on the bowel lumen.

5. It can be safely extended to include nearly one-half the circumference of the bowel, and three to four inches in continuity. There is no apparent reason why it should not be repeated as often as necessary at different levels of the intestinal tract.

6. In view of the rich vascular anastomosis and the mobility of both the bowel and its mesentery, if care be exercised in placing the sutures so as to avoid the trunk vessels, the effect upon the circulation is negligible.

7. Stability and permanence of the coaptation is readily secured through intelligent disposition of the sutures.

SUMMARY.

Peritoneal adhesions are of two kinds, those which are useful, and those which are harmful and dangerous.

It is futile to search for some agent that will banish adhesions from the realm of abdominal surgery, inasmuch as the processes involved in their formation are identical with those involved in peritoneal repair.

In dealing with peritoneal adhesions, the surgeon has recourse to three classes of procedures: (1) measures which prevent their formation; (2) measures which restrict their formation to the harmless variety; (3) measures which aid in their absorption.

Certain anatomical and physiological characteristics of the peritoneum have an important bearing on the problem of peritoneal adhesions; notably its extensive area, its remarkable absorptive power and ability to successfully cope with infection, the variable sensibility of different portions, the continuity of its endothelial surface, the rapidity with which it can form adhesions, and the completeness with which it can later absorb them.

Injury or death of the highly vulnerable surface endothelium is sufficient to set in motion the chain of pathological events which may terminate in dense adhesions.

Etiologically, there are a number and variety of factors involved, but they can all be grouped under the two heads—sepsis and trauma.

As specific prophylactic and curative measures, emphasis should be given to: (1) rigid asepsis; (2) the use of moist hot gauze; (3) careful covering of all raw surfaces; (4) avoiding unnecessary exposure; (5) restricting trauma; (6) gastro-enterostomy and entero-enterostomy; (7) returning the viscera to their proper anatomical relationship; (8) spreading out the omentum over the visceral surfaces before closing the abdomen; (9) careful closure of the peritoneum. A number of additional safeguards are available which have been tested and proven to be of value under certain conditions. The most reliable of these for general use are: (1) viable grafts of omentum or peritoneum; (2) lubricants; (3) judicious ante- and post-operative therapy—especially with reference to posture, catharsis, enemata, and length of stay in bed.

The field of specific chemotherapy offers the brightest hope for future progress.

Success in the management of the more aggravated adhesion case depends largely upon accurate clinical diagnosis, followed by intelligent operative procedures, as pointed out.

In properly selected cases, the use of adjacent mesentery for covering raw bowel surfaces possesses distinct advantages over all methods hitherto proposed.

In conclusion, I desire to express my thanks to the Pathological Department of the Johns Hopkins Hospital for giving me the privilege of testing on the fresh cadaver the method above described.

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CONSIDERATIONS RELATING TO THE PATHOGENESIS AND DIAGNOSIS OF SURGICAL DISEASES OF THE PANCREAS.*

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THE intimate relation each disease met with in the upper abdomen bears to the other, especially from the viewpoint of cause and effect, makes it well nigh impossible to separate either from the other without omitting much valuable information common to them all; indeed, it was through a search into the complications of bile-duct disease, especially calculi, that our present knowledge of pancreatitis was acquired.

Embryology.—The subject must therefore involve a consideration of not only the existence of the three major organs, the liver and its ducts, pancreas, and duodenum, but the surgeon must have, as well, a working knowledge of their embryology, anatomy, and physiology, in order that he may properly understand the important relation the organic internal secretions bear to digestion and assimilation; for it is now generally accepted as proven that the control of this function by the internal secretions takes precedence during embryologic evolution over the nervous system, and retains a large measure of that responsibility even after the central nervous system is developed. The duodenum, in this anatomic trio, is the trunk, with the bile and pancreatic ducts its branches. The intimate anatomic relation of the stomach, duodenum, liver and pancreas, through the close association of the main ducts of the two latter and the viscera, must always be borne in mind in undertaking differential diagnosis. For example, the pancreas, which is an organ of both external and internal secretions, has its internal secretion intimately associated with

* Read before the West Branch of the Philadelphia County Medical Society, Oct. 17, 1911.

the glands of Brunner, situated in the duodenum, while its external secretion is even more closely associated with that of the bile.

Anatomy.—The protected position of the pancreas emphasizes its importance. The head lies closely embraced by the duodenum just beneath the pylorus, its body behind the stomach covering the great vessels, while its tail reaches over to the spleen and left kidney. The embryologic development of the pancreas, as two separate outgrowths from the primary foregut to afterward coalesce, is important to keep in mind, as it often retains two separate ducts, Wirsung and Santorini. The latter is the direct duct, yet in 20 per cent. of cases it undergoes complete obliteration, while in the remaining 80 per cent. it anastomoses with the indirect or duct of Wirsung, and empties by a separate orifice into the duodenum. In one individual out of ten the duct of Santorini is even of larger calibre than the duct of Wirsung. In such cases as this, the pancreatic secretion will be emptied into the duodenum even when the Wirsung duct is occluded.

The common bile-duct in conjunction with the duct of Wirsung enters the under surface of the second portion of the duodenum through a vestibule, the ampulla of Vater, where the secretions from the two glands are mixed before they take their respective places in the digestive process.

The anatomic relation of the main duct of the pancreas and that of the liver has its physiologic significance in showing the importance of associating bile in the process of digestion. From a pathologic standpoint, this association is most unfortunate, for it is the factor in causing many of the morbid processes to which both the pancreas and biliary passages are subject. In two-thirds of all cases the bile-duct passes directly through the head of the pancreas on its way to the duodenum. This fact, together with the close vascular and lymphatic association between the bile passages and pancreas, furnishes the pathogenesis of the greater number of the cases of pancreatitis. It is obvious that infection of one of these organs must be easily transmitted to the other, though this, of course, does not ex-

clude such constitutional dyscrasias as mumps, typhoid fever, phthisis, syphilis, and arteriosclerosis having a large responsibility in bile-duct and pancreatic disease. Pressure of the swollen head of the pancreas on the common bile-duct is a causative factor in epidemic jaundice, second only in frequency to cholelithiasis and duodenitis, though mumps, according to collective investigation of Egdel, is responsible for 10 per cent. of all cases of pancreatitis.

Of greatest interest is the association of cholelithiasis with chronic interstitial pancreatitis, the so-called interlobular form. This is due to duct obstruction from gall-stones, with infection always present, though fortunately usually mild. The interacinar form of pancreatitis is less commonly met with and differs from the rough and nodular interlobular variety in being smooth and tough with glycosuria usually present in the latter on account of involvement of the islands of Langerhans, though in the interlobular variety these areas may also become involved, causing secondary diabetes. It is generally admitted that chronic interstitial pancreatitis may exist for years without appreciable change from the original disease, though during this period the proteolytic, the lipolytic, and diastatic properties of both its external and internal secretions will be noted in the characteristic findings in the intestinal excreta and the defect in its metabolic function of converting both sugars and fats.

This chronic process will not only cause disease of contiguous organs or viscera, but will, and generally does, extend to remote ones through faulty metabolism.

Symptoms.—Symptoms that arise from pressure on the common bile-duct, due to the swollen head of the pancreas, cannot be differentiated with accuracy from those due to cholelithiasis. Both conditions cause jaundice, though that caused by pancreatitis is more apt to be permanent, with associated cutaneous pigmentation and a rapid effect on the constitution evidenced by a profound and progressive emaciation, the result of pancreatic insufficiency (*achylia pancreatica*). While in bile-duct obstruction uncomplicated by pancreatic disease,

pain and jaundice exist during the acute attack of colic only or during the temporary passage of calculus through the common bile-duct and when cholelithiasis and pancreatitis co-exist, there is a distinct point of tenderness upon pressure, half way between the ninth rib and the umbilicus, and a second area of tenderness over the right rectus abdominis muscle, above and to the right of the umbilicus.

If duodenal ulcer can be excluded, these symptoms would justify diagnosis of pancreatitis. Reflex pain radiating to the midscapular or left scapular region, together with absence of emaciation and the presence of hyperchlorhydria and pain when the stomach is empty, will exclude duodenal ulcer. In pancreatitis it is generally possible to detect an enlarged, hardened, and tender pancreas, extending across the upper abdomen, and a careful study of the alimentary excreta will reveal large light-colored, grassy stools, which are not found in duodenal ulcer. But most important is the discovery of nucleated muscular fibres in the stools, as the presence of these is distinctly a feature of pancreatic insufficiency, and occurs in pancreatitis only; as a further laboratory effort toward establishing a diagnosis the urine should be examined for Cammidge crystals. Emaciation is at times so rapid as to suggest malignancy.

ACUTE PANCREATITIS.—The pancreas has been aptly described as the salivary gland of the abdomen, and, were it not for its association with the main duct of the liver, it would probably seldom be the seat of acute inflammation, the symptoms of which are sudden onset of agonizing pain, deep-seated and referred to the right of the epigastrium and followed by great prostration, rapid pulse, early elevation of temperature, nausea, vomiting and early tympanites accompanied by (according to Opie, Ochsner, and Halstead) marked cyanosis, especially about the face and abdominal walls. With this group of symptoms, as they are the most classic, it is difficult to make a diagnosis, because the upper abdominal muscles are extremely tense and the abdomen generally tympanitic, so that this group of symptoms does not differ materially from those arising from

such acute conditions as intestinal obstruction, perforation of the hollow viscera, renal colic, or ectopic gestation.

Sugar may be present in the urine, in some cases, where chronic pancreatitis has existed for a considerable period, free fat (according to Fitz) may be seen in the fæces upon inspection, and occasionally a tender, tumorous mass can be felt. It is fortunately a condition where accuracy of diagnosis is not essential, since the simulating conditions all require surgical intervention.

The patient is usually at or about middle life, fleshy, and with an alcoholic history, and he rapidly develops a bronzed appearance (hæmatogenous jaundice). This pigmentation is characterized by uniformity and absence of mucous membrane discoloration. From the onset of the attack these patients are in a state of collapse, and therefore not promising subjects for operative treatment, yet immediate operation offers the only possibility of cure. Robson, by this means, had 23 recoveries out of 59 operated.

The operative procedure consists in a median abdominal incision above the umbilicus, which will disclose an excessive amount of blood-stained peritoneal fluid, usually stones in the gall-bladder and common duct, while the pancreas will show hemorrhagic infiltration and numerous areas of fat necrosis, recognizable as yellow spots, while the swollen organ itself will give on palpation a semi-fluctuating feel.

The treatment, which is surgical from the onset because of the profound toxæmia that actually ushers in the attack, should consist of promptly establishing free drainage through incisions made in several parts of the gland. If excessive hemorrhage ensues, it can be controlled by gauze packing held in place by sutures. The final step must be to establish free drainage through the abdominal incision anteriorly by means of either perforated rubber or glass tubes thoroughly protected by gauze pack. Posterior drainage, which is advocated by some, cannot be so effectual as the anterior route, because the head of the pancreas, which is the seat of greatest infection, lies in front of the vertebræ and is therefore not directly accessible from that point.

If stones are present in the gall-bladder or bile-ducts, or there is acute infection of the bile-ducts with jaundice, it is necessary in addition to free the gall-bladder and ducts of accumulated calculi, and establish drainage by a right lateral incision through the anterior abdominal wall, provided the patient's condition will permit.

SUBACUTE PANCREATITIS.—There is a certain number of acute cases where, because of either a lessened amount of virulency or an impairment in the activity of the infective products, the severity of the symptoms as noted in the acute form of the disease are less marked, and a more favorable outlook from the onset is to be expected. The patient has passed through the height of infection, and thereby built up a resistance that offers to surgery a better prognosis.

When the abdomen of such a case is opened, there are found scattered through the omentum, mesentery, and fatty tissues areas of fat necrosis, which have resulted from the escape of the fat-splitting ferments of the pancreas with here and there multiple foci of purulent material.

Treatment.—Treatment consists in evacuating the abscesses and draining. Calculi in the gall-bladder and the bile-ducts should be removed and free drainage instituted. Search must also be made for hæmatoma, which may be found either in the pancreas or adjacent tissues, the result of pancreatic apoplexy.

CHRONIC PANCREATITIS.—Chronic interstitial pancreatitis is usually characterized by an antecedent history of indigestion with mild gall-stone attacks. The fact that two-thirds of all common bile-ducts pass through the head of the pancreas is sufficient to emphasize the certainty that, in at least two-thirds of the cases of chronic pancreatitis, drainage through this duct must be interfered with, making jaundice a conspicuous objective symptom, though in a certain number of cases this symptom may be absent and yet the common bile-duct may be distended. This fact shows that dilatation of the common duct may exist independent of gall-stones, and both the duct and the gall-bladder may be distended without jaundice.

Courvoiser estimates that because of gall-stone irritation

84 per cent. of the cases of common duct stones have atrophic gall-bladder. Therefore, the size of the gall-bladder in chronic interstitial pancreatitis depends upon whether gall-stones are or have been present.

Pancreatitis may cause such marked distention of the gall-bladder and primary jaundice without calculi being present, that malignancy may be suggested. When, however, the latter is the cause of the obstruction, the glands in the fissure of the liver become early involved, and the pressure arising therefrom so interferes with portal circulation that ascites early develops.

The intestinal excretion is large in quantity and greasy. Microscopically examined it will show nucleated muscle fibre and fat. If jaundice is absent the stools will be a bright yellow color, due to an absence of the pancreatic juices. These patients abhor meats and fats.

Treatment.—The treatment of chronic interstitial pancreatitis is equally surgical from the onset, though, because of milder degree of infection, radical treatment can, in some instances, be delayed to give medical treatment a chance. The latter, however, should not be persevered in until it has been proven useless, for if thus delayed, surgery may not be given its full opportunity.

The underlying principle of the surgical treatment is to establish either temporary or permanent isolation of the pancreatic and bile-ducts, so that infection from either can as nearly as possible be removed from the other. In undertaking to clear the ducts of the partly obstructing calculi, it is important for us to bear in mind that some of them may be concealed under the enlarged head of the pancreas, or small ones may be lodged in the hepatic ducts, above the primary division. This can always be avoided by careful palpation. After the removal of all stones and the freeing of the bile-ducts and pancreas from adhesions, a large flexible probe should be passed through the common duct into the duodenum. This, together with external gall-bladder drainage, will usually not only establish but maintain free drainage and prevent recurrence of infection.

Cholecystostomy, in my experience, is sufficient to cure the majority of these subjects, and is therefore the procedure of election, as it enables one to remove calculi and establish temporary external drainage more satisfactorily than any other operative procedure that I have generally employed. In cases, however, where it is essential to promptly supply the bile to the intestines for aiding digestion, cholecystenterostomy is the operation of choice. If there is total obstruction of the common duct from pressure of the head of the pancreas, then cholecystduodenostomy or cholecystojejunostomy will be required to overcome the obstruction.

The surgical treatment of chronic interstitial pancreatitis, unless calculi are present, is directed toward the biliary tract rather than the pancreas, and is best accomplished by diverting the bile to the surface or to a new place in the gastrointestinal canal, by some of the several operative procedures now so generally employed. Cholecystostomy is indicated in by far the greatest number of cases. The methods of employing the stomach and the hepatic flexure of the colon for the purpose of diverting the bile have not, as yet, taken precedence over those above referred to, and which are more generally employed.

GASTRIC AND DUODENAL ULCER.*

A RECORD OF 110 RECENT OPERATIONS.

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SINCE my first deliberate operation for the relief of symptoms due to chronic gastric ulcer, in March, 1900, a very large number of these cases have come under my care. It may, I think, prove interesting and instructive if I very briefly place on record some lessons to be learned from a study of these cases. In doing so, I do not propose to waste time by any recapitulation of well-established facts, but to see how far we can throw any fresh light on what is one of the very commonest ailments which we are called upon to treat.

For the purposes of this paper, I have collected all my cases since September, 1908. The list shows 110 cases, with three deaths, all of which occurred in my private practice—one from pneumonia, one from plastic peritonitis, one from wound infection caused by the patient herself.

This represents a mortality of 2.7 per cent. With greater care in the selection of cases and improved technic, I have no doubt still better results can be obtained.

My cases were in no way selected. Several of them were so wasted and feeble that it seemed very doubtful whether they could stand a general anæsthetic. No case was refused except on the ground that a thoroughly efficient course of medical treatment had not been submitted to. In several instances the operation was a very complicated and difficult one.

Two patients were over sixty years of age.

When we consider the debilitated and unhealthy condi-

*Read before the Ulster Medical Society, March 2, 1911.

tion of a large number of sufferers from long-standing gastric ulcer, I am afraid we must always be prepared to face an appreciable risk. It is never right to underestimate the gravity of any operation, but I am satisfied that we may quite safely put the risk in an average case as not higher than 2 per cent.

There can be no doubt whatever that this is decidedly less than the ordinary medical risk. The risk of perforation alone cannot possibly be put below 5 per cent., and is probably much higher. The risk of hemorrhage is difficult to estimate, there being no reliable statistics, but experience teaches every medical man that this is not an uncommon cause of death.

During the past three years I have known one patient die from hemorrhage, and two from perforation, while considering the question of operation. Several of the cases operated on by me were on the verge of perforation, all the coats of the stomach having been eaten away except the peritoneum, which fortunately was strengthened by adherent omentum or plastic lymph, nature having done all in her power to avert a calamity.

The medical risk is, however, a somewhat vague and indefinite one which may never materialize; and which it is fair to point out, may not terminate fatally if promptly and skilfully treated.

The operation risk is one which is deliberately faced, and this requires some degree of courage on the part of the medical attendant who recommends it, and still more in the patient who submits to it.

In this connection I would like to point out the exceptional mortality attending perforation occurring in the victim of a dilated stomach.

In January, 1911, a railway porter consulted me. He had a greatly dilated stomach, and was very weak and exhausted. He went into hospital on a Saturday afternoon with a view to operation on the following Tuesday. At 11 o'clock on Saturday night he suddenly perforated. In my absence from town Mr. Fullerton very kindly operated on him within three hours after perforation. He never rallied,

however, from the initial shock, and died on Sunday forenoon.

In 1900 I saw with Dr. Calwell in the hospital a man with a greatly dilated stomach. We both strongly urged an operation, which was declined. He went to the convalescent home where he perforated and died in a few hours.

These cases are very liable to perforate, and when this accident happens, the peritoneum is simply drenched with stomach contents, often in an advanced condition of decomposition. The result is a profound toxæmia, almost certain to terminate fatally.

The study of a series of cases such as I now submit, in which the condition of the stomach has been actually inspected during life, should, I think, help us to appreciate, at their proper value, the individual signs and symptoms on which we are accustomed to rely for a diagnosis of gastric or duodenal ulcer.

These symptoms—pain, vomiting, hemorrhage, local tenderness, and local hyperæsthesia—and the evidence furnished by examination of the stomach contents, I now propose to consider very briefly.

Pain is the only symptom common to all cases, and though an ulcer may be present either in the stomach or duodenum, and may even perforate all coats of the organ before the onset of pain, I am satisfied that no physician would feel justified in coming to a diagnosis of ulcer in the absence of this cardinal symptom.

To be of any real value, the pain must have a definite relation to food. The patient must be quite clear as to the effect of a meal, and of different kinds of food.

Pain coming on at night is of the greatest importance, especially when it wakens the sufferer at a definite hour. This does not occur in the purely neurasthenic type.

I have never failed to find a well-defined ulcer where typical night pain was complained of.

Pain which radiates into the back is also of special value, and in my experience has generally been associated with an ulcer on the lesser curvature or on the posterior surface of

the stomach. I cannot, however, dogmatize on this point. It is merely the impression that has been left on my own mind.

I have operated on several cases of long standing, two of them with hour-glass stomach, in which the constriction would scarcely admit a single finger, who stoutly maintained they had never vomited. Pain was their one and only symptom, and as years went by it became steadily worse. "Hunger pain," a gnawing, aching, or burning pain, coming on two or three hours after food, relieved by taking more food, soda, or even a warm drink, is, when typical in its manifestation, especially if it come on at night, almost pathognomonic of duodenal ulcer.

The following case, however, shows that we must exercise caution ere expressing a dogmatic opinion:

A young married lady, aged twenty-nine, visited me on February 28, 1910, accompanied by her husband. She informed me she had come to arrange for an operation for duodenal ulcer. She had seen several medical men, had tried milk diet, and rest in bed, without benefit.

Her daily history, with slight variations, was as follows:

Quite comfortable when she got up in the morning; breakfast 9 o'clock, pain coming on about 11.30 to 12 o'clock, and getting worse till dinner at 1 o'clock. This meal at once gave relief, and she was quite comfortable till between 3 o'clock P. M. and 5 o'clock P. M., the interval depending on the nature of her dinner. Once the pain began it steadily got worse, so that if she happened to be down town shopping she was obliged to have afternoon tea, the result of which was prompt relief. She took her ordinary tea about 6.30, after which she generally remained well, but occasionally the pain came back about 8 o'clock. It, however, never came on after she went to bed nor wakened her at night. She had slight tenderness over the right rectus at the level of the umbilicus. This being below the usual site, I inquired whether she ever had an attack of appendicitis, but she could recollect nothing of the kind. At operation, March 6, 1910, her family medical attendant being present, we found a healthy stomach and duodenum. The appendix was $4\frac{1}{2}$ inches long. At a point 1 inch from the cæcum it was tightly constricted, the remaining $3\frac{1}{2}$ inches was distended to the thickness of an

index-finger, and the tip was fixed by adhesions. The appendix was removed. She made a rapid recovery, and her medical attendant informs me she has remained well since the operation.

This history at first sight appeared quite typical. The absence of night pain, and the position of such tenderness as appeared to be present, suggested the possibility of an appendical origin. Our incision was therefore made through the right rectus opposite the umbilicus, so that it could be extended up or down as required.

Another condition which sometimes gives rise to a false "hunger pain" is that arising from a number of smooth gall-stones in the gall-bladder. Two or three hours after a meal, when the stomach contents begin to pour freely into the duodenum, the gall-bladder contracts in order to meet the extra demand for bile; and in the presence of calculi this contraction may be associated with a dull gnawing pain. Other symptoms, however, on careful analysis generally suffice to differentiate between the pathological lesions.

Fortunately an error in diagnosis is of little importance in view of the treatment. Either condition calls for surgical interference, and the same incision, *i.e.*, a vertical one, through the right rectus exposes both gall-bladder and duodenum. I have twice had to remove gall-stones after completing a gastrojejunostomy. One of these was in the present series.

Now we come to the question of *local tenderness*. When present, tenderness on deep pressure is a sign the value of which cannot be overestimated. Unfortunately I have only found it in about 10 per cent. of my cases, and a careful investigation on this point has been made by me for some years. When typical, it has invariably been associated with some localized acute peritonitis around the ulcer.

An ordinary chronic indurated ulcer is *not* tender on pressure any more than a chronic appendix exhibits tenderness. Just as the onset of an acute manifestation in an old quiescent appendix is heralded by local tenderness and rigidity, due to peritoneal involvement, so too does epigastric tenderness and

rigidity indicate clearly and decisively that there is danger ahead. The ulcer is threatening to perforate; inflammatory reaction is taking place to seal and secure the danger zone.

In every instance in which this symptom was well defined the presence of recent peritonitis with inflammatory lymph was easily demonstrated to every one present at the operation.

If this lymph becomes organized into a firm adhesion the tenderness gradually disappears.

I wish to lay it down as a trustworthy clinical rule that tenderness is a danger signal, and that severe or persistent tenderness is one of nature's calls for help, and if neglected, the next and unmistakable call may be the tragedy of perforation.

Local hyperæsthesia, to which considerable weight is attached by some writers, was only present in about 3 per cent. of the cases examined by me. If present, both at the anterior and posterior terminations of the same spinal nerve, it is a very valuable sign, as it serves at once to eliminate neurasthenia. It is almost inconceivable that any one without a minute knowledge of anatomy could accurately locate tenderness along a single nerve in the absence of a pathological cause.

Hemorrhage has been distinctly noted at some period of the illness in 40 of my 110 cases. Allowing for the possibility that it may have been overlooked in some instances, I think it may fairly be estimated to occur in 40 per cent. I of course, only refer to visible blood. The regular examination of the fæces for microscopic traces of hemorrhage is never likely to be anything but an exceptional procedure, and is therefore of little practical value to the general practitioner.

In all my private and most of my hospital cases, a routine examination of the stomach contents has been made. Except in cases of dilatation, and to enable me to exclude malignancy by ascertaining the presence or absence of free HCl, I am bound to say that the information obtained has not been so helpful, from a practical stand-point, as I had at first anticipated.

Before deciding on such a serious step as operation, I think the stomach tube should be called to our aid in all but exceptional circumstances, and a chemical test should be made, so that nothing known to science may be overlooked.

Coming to the important question of treatment, I wish to lay down the rule that, in my view, gastric ulcer is essentially a medical disease. A very large number of these cases are curable by medical means. It is only when the complications arise, when relapses are frequent, or when the disease has become chronic that surgery has any vocation in non-malignant disease of the stomach. On the other hand I know of nothing more striking than the promptness and thoroughness of the relief which follows a well-planned operation on a stomach which is the seat of a chronic ulcer or its sequel.

Before discussing this question I would like to raise a point as to medical treatment. Is the stomach washed out as often as it should be? If properly used the stomach tube is not nearly so difficult to swallow or so uncomfortable as might at first sight appear. The application of a solution of cocaine to the soft palate and epiglottis, the assurance that there is no danger, and above all the carrying out of the instruction to breathe through the nose, will enable a patient to go through this ordeal even for the first time with very trifling discomfort.

To wash out the stomach each night, thoroughly empty it of acid contents, and minimize the effects of gastric stasis, which is present in a greater or less degree in all of these cases, is, I believe, good treatment. Contrary to popular opinion I do not consider hemorrhage a contraindication to this practice; I have frequently used it in cases subject to hæmatemesis, and have seen no ill effect.

Hæmatemesis is still best treated by medical measures. Of these I do not hesitate to say that in my experience the subcutaneous injection of normal horse serum has been incomparably superior to all others; 20 cc. of the serum may be given with an ordinary antitoxin syringe at the outset, and repeated night and morning, or oftener if desired. This need

not supplant other well-known medical remedies, but should never be omitted when the bleeding is at all dangerous.

Administration of ice so constantly resorted to seems to do more harm than good. Small quantities of adrenalin at frequent intervals, by the mouth, freely diluted, small doses of morphia, and the calcium salts seem to me to have been of some benefit.

As to surgical treatment, it is not my intention to discuss the details of the operation now so well elaborated. These principles I wish to lay down:

(1) Gastrojejunostomy should be performed, but this alone is not sufficient except in cases of simple pyloric stricture.

(2) The ulcer should be dealt with, either by (a) excision; (b) infolding.

(3) Where no pyloric obstruction already exists, partial closure should be brought about by a running suture involving the sphincter muscle, so as to offer an obstacle to its free dilatation, and thus encourage the gastric contents to leave the stomach by the new opening provided for that purpose.

(4) An examination should systematically be made for a chronic inflammation of the appendix or other lesion likely to cause subsequent reflex vomiting. Any such cause should be removed. The appendix can quite easily be removed in all but exceptional cases through an incision in the right rectus, the lower end of which need not extend more than one-half to one inch below the umbilicus. This incision through the right rectus controls the gall-bladder, stomach, and appendix.

It is very surprising how frequently a chronic appendicitis has been found in my later cases where it has regularly been looked for. Thus since January, 1910, I find I have removed the appendix in 19 out of 48 cases.

In my earlier practice I was content to leave the ulcer to take care of itself and simply perform gastrojejunostomy. I am now satisfied this is not ideal surgery. Our aim should be to leave the mucous surface of the stomach as far as possible intact. It is scarcely reasonable, for example, to expect digestion to proceed normally in a stomach, part of whose posterior

wall is formed by the pancreas, and whose movements are hampered by extensive adhesions. To dissect such a stomach off the pancreas is a very difficult operation, and results in a large hole being made in the stomach, which requires to be closed like a perforation.

At first I confess I shrank from this apparently risky procedure, but now I do not hesitate to undertake it, and the result fully justifies the time, trouble, and anxiety expended.

Excision of a chronic ulcer is by no means so simple a matter as the advocates of this as a routine method would have us believe. The operation is easy and attractive in a picture where all the clamps are applied with delightful accuracy, and the subsequent line of suture leaves a beautifully shaped stomach. This is not so in actual practice, as any one with experience of these cases can testify.

Where excision gives rise to difficulty, I therefore content myself with infolding the ulcer, a proceeding which if efficiently carried out is, as I have elsewhere demonstrated (*Trans. Roy. Irish Academy of Med.*, 1901, page 142), equivalent to excision, and at the same time easier, quicker, and probably safer. The effect of infolding is to secure complete rest to the ulcerated area, though as I have elsewhere pointed out (*B. M. J.*, Sept. 30, 1908) neither excision nor infolding is an efficient operation in itself. It should therefore invariably be associated with gastrojejunostomy.

This latter operation is now so well established a procedure, the broad principles so well recognized, that it requires little comment. At the same time I know of no operation in which the subsequent comfort of the patient depends so much on little details. To these I need not here refer. One point, however, has recently been forcibly impressed upon me. I operated on a man in 1909 for pyloric carcinoma, both layers of suture were done with linen thread as is the usual practice. He made a good recovery, and resumed his work as a car driver. One year later he was readmitted to the hospital with general peritonitis, due to perforation of the large intestine by a malignant ulcer. At the autopsy we found the

gastrojejunostomy opening in perfect working order. The inner or through-and-through suture still persisted, and was hanging into the opening very much like the handle of a bucket. This is as far as I am aware the longest authenticated duration of such a suture. Such persistence is clearly undesirable, and though the absence of free HCl in the malignant stomach may possibly account for it, I have since then used fine chromicized or formalin iodine catgut for this purpose, and found it quite satisfactory.

Several cases of hour-glass stomach are included in my list. These I now always treat by a double operation—a modified gastropasty followed by gastrojejunostomy *into the lower pouch*.

In all operations the abdominal wound is closed by three or more layers of catgut suture, either formalin gut, boiled in alcohol and stored in iodine and spirit, or chromicized catgut being used. Additional support is given by two or three deep silkworm gut stitches, which, however, do not penetrate the peritoneum. Sutured in this way the abdominal wall is absolutely secure. The patient may safely be allowed up in eight to ten days.

After-treatment.—All cases are nursed for two days in the Fowler or sitting position. If there is any evidence of shock, which is quite rare, continuous saline is administered, after Murphy's method, for twelve or twenty-four hours. Fluids are given freely by the mouth any time after six hours from operation. Thus it is quite common for my patients to have a cup of tea the evening of their operation.

Nursed in this position and treated in this way, anæsthetic vomiting is very rare. It probably does not occur in more than 5 per cent. Nothing indeed is more striking than the rapidity and easy recovery of these cases. They are allowed soups, jellies, puddings, porridge, bread and butter, eggs, etc., from the third day, and the second week chicken, fish and even potatoes.

I have shown that the immediate mortality should not exceed 2 per cent. What about the after-progress? We have

to admit that some complications do arise and finally that a few cases, probably not more than 3 to 5 per cent., derive no benefit. The worse the condition found at operation the more striking and complete the relief. The only troublesome sequelæ in my experience are two—(a) peptic ulcer of jejunum, (b) regurgitant vomiting.

I have had three instances of jejunal ulcer. All of them were operated on before the year 1907. Of these cases two were treated by myself, by excision of the junction containing the ulcer, closure of the posterior stomach opening, and substitution of an anterior Y gastrojejunostomy. Both recovered, and have since remained well. The third, a policeman, operated on for dilated stomach in November, 1907, was admitted to hospital for perforated jejunal ulcer on December 9, 1910. Mr. Kirk operated on him successfully, and he left the hospital in good health six weeks later.

These cases were all amongst my earlier operations, where I was making a longer jejunal loop than I now do.

This complication is undoubtedly a very serious drawback to the operation, but I think by use of an inner catgut suture, and by making a very short loop, it should be practically eliminated.

Regurgitant vomiting is a very troublesome sequel. It is quite rare in the modern operation where the jejunal loop is very short—"no loop." When present is due to:

(a) Obstruction by an adhesion causing an acute kink in the descending loop of the jejunum.

(b) Reflex irritation from an appendix, ovary, or other distant cause.

(c) Persistence of former hysterical vomiting.

If due to an adhesion it may sometimes be relieved by washing out the stomach and massage. The injection of fibrolysin into the abdominal wall has appeared beneficial in two cases in which I have used it. Failing this, the cause must be removed by operation.

Now as to the permanency of cure. I am afraid it would be unwise to contend that once a person has been operated on

for gastric ulcer, perpetual immunity from all and every type of indigestion can be guaranteed. My present list is too recent to admit of any inference on this point. It has been drawn up rather with a view to establish the comparative safety and immediate benefit of the modern operation.

I have many cases, however, operated during the past eleven years who continue in perfect health. One lady operated on in 1900, after years of suffering, has since married, has a family of five children, but has remained quite free of stomach trouble. Three cases operated on by me have been accepted by three different first-class British insurance companies without any addition to the usual premium.

I venture with confidence to submit that sufferers from chronic ulcer of the stomach or duodenum, which has failed to respond to medical treatment, may confidently be recommended to consider operative treatment, the prospects being an immediate risk not exceeding 2 per cent. with 90 per cent. probability of complete and permanent cure.

EARLY DIAGNOSIS OF CARCINOMA OF THE COLON.

BY JOSEPH BURKE, M.D.,
OF BUFFALO, N. Y.

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INASMUCH as a study of cancer generally is most interesting and instructive, cancer of the intestines, on account of its anatomical complications and variable symptomatology, should prove doubly so; particularly does this obtain when we take into consideration not the theory of the subject but the practical side of it, and this I will endeavor to do. The early diagnosis of any abdominal carcinoma is in many instances life-saving to the patient, in others a source of positive judgment to the surgeon or physician in the fatal prognosis. The early diagnosis of primary cancer of the liver, spleen, or pancreas is seldom positively made, because cancer in itself gives rise to no characteristic symptoms, its resulting complications being sometimes first manifested long after the beginning of the malignant process; but in carcinomata affecting the gastrointestinal tract, depending entirely upon the situation as well as the degree of the progress of the growth, the early diagnosis is in a great many instances positively determined, and the results of the early surgical attack a boon to the patient and a source of gratification to the surgeon.

The early symptoms of cancer of the colon are for a long time very indistinct and difficult of interpretation, and, apart from the anatomical site of the cancer, they depend upon three factors: first, stenosis, second, accompanying intestinal catarrh, and third, ulceration of the growth of either the mucous membrane or externally into some other organ. This last fact brings to my mind a case (J. W., aged 55 years) of carcinoma of the sigmoid that I saw about a year ago in which the patient's first symptoms were those of colitis and loss of weight and strength. It was only when distressing bladder disturbances began that he sought medical aid and

the true nature of the pathology was suspected because there had occurred an ulceration of the growth from the sigmoid into the bladder with the resulting communication of the interior of the colon with the interior of that viscus. In this case when the patient complained of diarrhoea he affirmed also that the colicky pains preceding and accompanying the emptying of the bowel radiated to the anus. Had I interpreted this symptom as Rudolph Schmidt points out, my suspicion of sigmoid cancer would have been immediately aroused. In this instance no tumor could be determined by abdominal palpation for a long time, and rectal examination showed no pathology. It was only when severe cystitis developed and gas escaped through the urethra that the diagnosis was made.

When a pale patient, who up to a certain given moment has enjoyed perfect health, particularly as regards his digestion, suddenly, with or without dietary indiscretion, *e.g.*, eating of flatulence-producing vegetables, begins to suffer from colicky pains in his abdomen with rumbling noises, and either in addition to obstinate constipation or diarrhoea notices a great loss of weight and increasing muscular weakness, cancer of some portion of the colon should be immediately suspected; when the stools contain blood or mucus or pus, or all three at the one time, the further suspicion of cancer is strengthened; and if a mass is found in any part of the abdomen with or without visible peristalsis, the almost positive determination that a cancer is present is made. In this connection I want to emphasize the fact that tumors of the sigmoid are very rarely palpated in the early stages; what we do sometimes feel and interpret as sigmoid cancer is either chronic inflamed and enlarged colon or scybala above the strictured bowel; that not always where we find a mass in the abdomen does it signify the exact location of the suspected cancer, as was demonstrated in a case of another carcinoma of the sigmoid flexure I once saw, in which a hard mass could be palpated in the left upper quadrant and the diagnosis of cancer at that point was made, but the autopsy revealed a circular scirrhus carcinoma of the sigmoid, and the mass that appeared in the upper por-

tion of the descending colon was hardened fæces. This point is important on account of the surgical attempt to relieve the pathological conditions, and the placing of the necessary incision. If a doubt exists as to the anatomical situation of this tumor, the X-ray in recent time has become a valuable adjunct to our diagnostic armamentarium, as a case which I will describe here will aptly illustrate.

Mr. P. Z., Lockport, N. Y., aged forty years; occupation, broom-maker.

Family History.—Gives no evidence of malignant disease.

Previous History.—Patient affirms that he never suffered from any illness up to the time of the present one. No infections.

Present Illness.—About a year ago patient began to complain of gas and pain in the right side of the abdomen; the exact localization was indefinite, but the pain was referred to the right quadrant. The bowels have been loose, and lately there has been a watery diarrhœa, and for this reason as well as for the colicky pains in his abdomen, he seeks the advice of a physician. His appetite is very good. Up to one year ago patient's digestion was perfect; he never suffered from bowel trouble until then, when he suddenly noticed this looseness. Lately he complains of a feeling of weakness and is easily fatigued upon exertion. He has lost 28 pounds during the past year. He has never passed any blood; the only difference in the nature of the alvine discharges was that they had become watery. There has been no nausea, no vomiting.

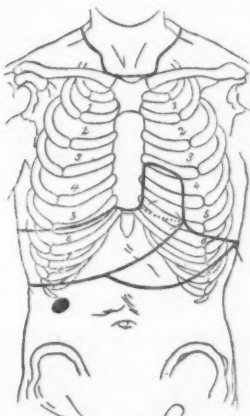
Status Præsens.—Patient shows a peculiar, almost yellowish, paleness of the skin and mucous membranes. He is emaciated. Conjunctivæ not icteric; tongue somewhat coated but moist. There are no palpable lymphatic glands in the neck, nor in any other part of the body. Skin lax, shows loss of fat. Lungs and heart normal. Abdomen: The abdomen is flat, no ascites; there is no visible peristalsis. On the right side, just above a line drawn through the umbilicus and below the end of the eleventh rib, is a slight elevation (Fig. 1). Palpation reveals this to be a hard, somewhat tender mass, which is irregular in outline and movable, but is not attached to the lower border of the liver. It is movable during inspiration; it can be held fixed during expiration. Bimanually, ballottement can be distinctly

felt. There is no pulsation over the tumor, and it cannot be made to disappear under the ribs. There is no rigidity of the right rectus muscle. There can be heard no gurgling, no peritoneal friction sounds over the tumor. Urine normal. Liver and spleen not enlarged. Fæces show no pathological elements, no blood. Blood: secondary anæmia; hæmoglobin 75 per cent.

Considering in this case:

(a) Sudden disturbances of bowel function, after previous perfect health; (b) loss of weight, 28 pounds, and increasing muscular weakness; (c) colicky pains in abdomen; (d) secondary anæmia, and (e) tumor in the right hypochondrium—

FIG. 1.



Case P. Z., outline of tumor.

the diagnosis of malignant tumor was immediately suspected. The fact that the tumor was hard, tender, and irregular, not round and smooth in outline, passively movable, and could be held fixed during expiration, excluded gall-bladder in the diagnosis; and, further, the fact that the mass could not be pushed up under the ribs and made to disappear, argued against kidney origin; but ballottement characterizes kidney tumor, so does a mass which moves downwards with inspiration and can be held fixed during expiration, and both of these signs were present in our case. Coupled with this the observation that there was no blood nor mucus nor pus in the stools, no peritoneal friction sounds heard over tumor, no peristalsis visible, caused us to hesitate a little in our positive declaration that we had to do with

hepatic flexure carcinoma. I had two X-ray plates made of the colon which I present here; it will be seen how beautifully the differential diagnosis was positively determined. In Fig. 2 will be observed the rectum, sigmoid, descending and transverse colon, and then an abrupt cessation of the shadow, as if the bowel were cut off at the hepatic flexure; it will be noticed where the cæcum should be seen are two or three fine shadows, showing a trickling of bismuth through the constricted tumor mass at the flexure.

In a second plate (Fig. 3) taken fifteen minutes after the first, will be noticed a little more distinctly shadows of the bismuth that has passed through after fifteen minutes retroperistalsis. The X-ray, as may be seen, makes very plain that we had to do with constriction of the hepatic flexure of the colon and excludes the kidney. I want to say here that a sometimes very valuable aid in the differential diagnosis of tumor of colon and kidney, that of artificial inflation of the colon, was not done because we thought it unnecessary and dangerous in this instance. Immediate operation was advised and it was done three days following the X-ray examination.

Operation at Sisters' Hospital, August 22, 1911: Upon opening the abdomen in the right semilunar line, with the middle of the incision corresponding to the level of the umbilicus, I found a hard mass about the size of a lemon which was part of the hepatic flexure of the colon. It was attached by adhesions to the posterior wall of the abdomen, but was with some difficulty freed. The cæcum, ascending colon, and a part of the transverse colon were made movable by an incision into and freeing of the parietal peritoneum and delivered. The appendix was somewhat congested, the cæcum dilated, and the ascending colon contracted to about half its length, a point which Moynihan calls attention to in his work. The ileum was divided between clamps as was also the transverse colon; the lower end of the ileum, the cæcum, the ascending colon with tumor, and part of the transverse colon were removed, as well as some enlarged glands of the mesentery. The ends of the remaining parts of the ileum and transverse colon were closed and inverted. Then a side-to-side anastomosis of the ileum with the transverse colon was made in the direction of the normal fecal current. I made the anastomosis about two and one-half inches in length, using

FIG. 2.



Case P. Z., bismuth test, before operation.

FIG. 3.



Case P. Z., bismuth test, before operation. Plate taken fifteen minutes after Fig. 2.

FIG. 4.



Case P. Z., after operation.

FIG. 5.



Case P. Z., after operation. Plate taken ten minutes later than Fig. 4.

the clamp method and Connell suture, reinforced all around with Lembert suture. After a thorough toilet of the peritoneum the wound was closed in the usual manner.

On the twentieth day after the operation, the day previous to patient leaving hospital, cured, two X-ray plates were made, to which also I wish to call attention. In this plate (Fig. 4) will be seen the bismuth-filled ascending and transverse colons, and some of the bismuth forced through the anastomosis opening into the ileum. In the plate (Fig. 5) taken ten minutes after Fig. 4, the half of the transverse colon nearer the anastomosis is seen contracted and almost empty of bismuth, while the ileum is seen to contain much more bismuth than in Fig. 4.

I wish to thank Dr. Leonard Reu for these excellent X-ray pictures.

Differential Diagnosis.—The differential diagnosis of cancer of the colon can best be considered by a study of the flexures, situations where the growths most frequently occur.

Beginning at the cæcum, we find two pathological conditions that can simulate carcinoma, appendicitis in old people and ileocaecal tuberculosis. There are cases of appendicitis, though very rare, that cannot be absolutely determined in the early stages, and only when an acute recurrence is present is the benign nature of the disease determined; there are others in which the differential diagnosis between cæcum carcinoma and appendicitis in the beginning gives rise to great speculation, when there exists elevation of temperature and sometimes repeated chills, as well as acute local pain. But here as well as in all cases the taking of a very careful previous history up to the time, and exact detailed symptomatology of the present illness, ought to be of great diagnostic aid. Some observers have claimed that temperature in itself speaks against carcinoma, but in this they absolutely err, because temperature elevation is a not seldom phenomenon in gastro-intestinal cancer, as Freüweiler, of Zurich, conclusively demonstrated. Fromme, of Halle, claims that this fever in cancer is due to destruction of the primary tumor, large lymph-channels being opened up, and a great amount of bacteria brought to the

lymph-glands and their toxins permeating the blood. Hence I would suggest in the differentiation of carcinoma from appendicitis in elderly people, that we pay absolutely no attention to the temperature as against carcinoma. It matters little, however, to the surgeon as both conditions demand early surgical attack, and one who opens the abdomen to operate an appendix ought to be ready to do a radical operation in case his pathology proves to be cancer. Again, as Tuffier has reported, there are cases of malignant diseases of the cæcum with abscess formation.

Since writing the above paragraph concerning the differential diagnosis of cæcum carcinoma in which fever is present as a prominent symptom, I have seen and operated on a case, the history of which I think ought to be given in detail. On account of the suddenness of the onset of abdominal pain, temperature 103° , pulse 105, and exquisite tenderness on palpation, as well as a well-defined mass in the right iliac region, a diagnosis of acute appendicitis with perityphlitis was suspected by another physician who saw the patient on the second day of the acute attack. I was invited by the attending physician to see the patient, on the twelfth day, and after going into the history of the case minutely, obtained the following data:

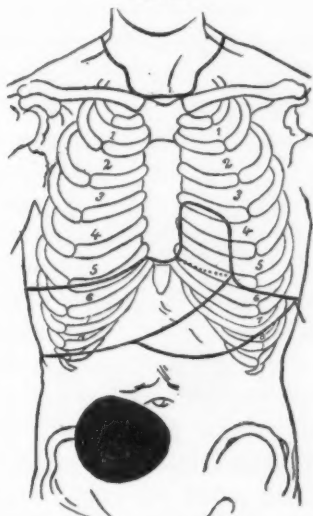
September 28, 1911: Mrs. C. O'B., fifty years of age, married, one child twenty-two years of age. Father died at seventy-eight of paralysis. Mother at sixty-two; cause indefinite. Patient as a child never had any infectious diseases until she was fourteen years of age, when she suffered from double quotidian malaria. Last menstruation five months ago.

Present Illness.—Up to one year ago she was perfectly well and able to do her household work, including washing, without fatigue. At that time and up to six months ago she noticed that she was losing weight and that she was easily fatigued in doing her work, and had to give it up. Her daughter noticed that her complexion was becoming paler and that she looked bad. About six months ago she noticed that unless she took a physic (Cascara) every day her bowels would not move. This obstinate constipation has persisted up to the present time; there has been

no diarrhœa. She never noticed blood nor pus nor mucus in the stool. She has complained of pain when about to urinate and griping pains just before the bowels act. She has never vomited, but lately her appetite has been poor. Twelve days ago she began to complain suddenly of cramps in her right iliac region, which I have already described.

Status Præsens.—The patient has a yellowish, pale, anæmic color. The mucous membrane is pale; there is no jaundice of the conjunctivæ; no glands palpable in any part of the body. Tongue clean and moist; heart and lungs normal.

FIG. 6.



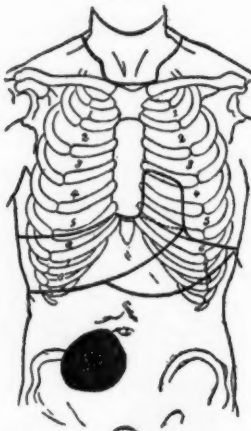
Outline of tumor Sept. 28, 1911.

Abdomen: Liver and spleen not enlarged; inspection of the abdomen shows a rounded prominence, the centre of which corresponds to a point an inch below McBurney's point. There are no visible peristaltic waves; palpation reveals this swelling to be a hard, exquisitely tender, somewhat uneven mass, which can be slightly moved from side to side (Fig. 6). The mass extends about a finger-breadth above a line drawn through the umbilicus, and extends to the left about an inch beyond the middle line. It measures in its longitudinal diameter 5 inches, in its transverse diameter $4\frac{1}{2}$ inches. Over the centre of this tumor there is a dull tympanitic note. The skin and abdominal wall

are movable over the tumor, particularly near the anterior superior spine. There is no rigidity of the right rectus muscle.

October 5: Temperature, 99°; pulse, 118; respiration, 20. There is less pain complained of. Left lateral position causes dragging pain referred to the site of swelling in the right iliac region. The mass is not so tender to palpation, and its limits are more confined than five days ago. It goes about to a line drawn through the umbilicus above and not quite to the middle line laterally (Fig. 7). The tumor is not respiratory movable. There is no rigidity of the right rectus muscle. The skin and

FIG. 7.



Outline of tumor Oct. 5, 1911.

underlying structures comprising the abdominal wall over the site of swelling can be moved as if separated from and gliding over the tumor. Blood shows the following: Hæmoglobin, 75 per cent.; white cells, 10,900; polymorphonuclears, 81 per cent.; large, 13 per cent.; small, 6 per cent.; erythrocytes, 3,500,000. Stools contain no blood, no mucus, no pus. Urine negative, Diazo reaction not present.

Considering in this case: (1) no previous infections excepting malaria; (2) loss of weight, 29 pounds in six months; (3) obstinate constipation; (4) increasing muscular weakness; (5) griping pains just before defecation; (6) the absence of vomiting, especially at the onset of and during the recent febrile illness; (7) yellowish pale color of skin; (8) the fact that the

tumor persisted even after the cessation of the fever; (9) the clean moist tongue, which personally I have never seen in any acute abscess case; (10) and this is the most important point and the one on which I place the greatest dependence, and which as far as I am aware has not had attention called to it in the literature, namely, the fact that the skin and underlying structures of the abdominal wall over the site of the swelling could be moved by the palpating hand as if separated from, and gliding over, the tumor. I have never observed a case of abscess in the abdomen large enough to see and outline where the muscles over it were not on guard and which could be moved as above described. I did not therefore hesitate to affirm that we had to do with, not appendicitis with abscess, but carcinoma of the cæcum, a diagnosis the correctness of which was demonstrated at operation. Fever and 81 per cent. polymorphonuclear leucocytes in a count of 10,900 and still no acute abscess are observations to be considered in a negative way.

I made an incision through the middle third of the right rectus muscle, splitting the fibres. Upon opening the abdomen I found a mass about the size of two fists. The tumor proved to be a carcinoma of the cæcum. The omentum attached to the tumor mass was ligated off in sections. The tumor itself was not adherent to the surrounding structures except slightly to the posterior abdominal wall. The cæcum was delivered, the parietal peritoneum external to it was cut and freed, and the cæcum and ascending colon raised upward and toward the median line, the mesentery of the ileum and of the cæcum were ligated in sections with heavy celluloid linen. Inasmuch as the mesentery of the terminal ileum was short I removed about 14 inches of the ileum, the cæcum with mass, and ascending colon, between clamps. The end of the remaining colon I closed with a continuous suture; touched the line with carbolic acid and alcohol, and then with the Lembert continuous suture buried the stump. The end of the ileum was treated in like manner, and a side-to-side anastomosis made of the ileum with the transverse colon in an isoperistaltic direction. The anastomosis opening was about an inch and one-half in length in its interior; the omentum was sewed over the anterior suture layer of the anastomosis. The toilet of the peritoneum was made in the usual manner and the abdominal wound closed.

The post-operative history is as follows: During the first forty-eight hours patient vomited three times, complained of no pain, no bladder disturbances; the abdomen was soft, and liver dulness normal. The pulse ranged about 120, respiration 24. At the end of the second day an enema brought some gas and fecal colored water; on the third day, after a soapsuds enema, patient passed considerable flatus and some fecal colored matter. On the third day the pulse suddenly became accelerated, respirations went up to 50, lips became cyanosed, and signs of hypostatic pneumonia developed, until the fourth day, when death occurred, the cause of death being hypostatic pneumonia. A postmortem was not allowed.

I have no doubt that had I been called to attend the patient in the early days of her febrile illness, instead of on the twelfth day, I would have been deceived by the clinical picture presented, and I am sure there is no doctor who would not have suspected an acute appendicitis or a perforation of the cæcum with abscess formation, had he been called early to see the case, because we do not know definitely whether or not at that time there had been a complicating local plastic peritonitis. I do not know how to explain the reduction of the size of the mass from September 28 to October 5, as shown in these pictures, except possibly an acute plastic peritonitis existed, in the omentum, which was found adherent to growth, and absorption of the exudate took place.

In differentiating cancer from tuberculosis of the cæcum, however, most careful examination of both lung apices for healed tubercular processes, the presence of the Diazo reaction in the urine, the finding of the tubercle bacilli in the stool, and lastly the positive Von Pirquet reaction, should guide the surgeon in the right direction. There are cases of ileocæcal tuberculosis that even after removal cannot be differentiated from cancer except by careful microscopical inspection.

The differential diagnosis of hepatic flexure carcinoma we have already discussed in detail in our case report; the chief causes of error are gall-bladder and liver neoplasms, and kidney tumors.

I saw a case (Mr. C. W., sixty-three years old), however, about two months ago, that, on account of a hard painful mass about at the hepatic flexure, the thought of carcinoma of that part was taken into consideration, because the patient had lost considerable weight within a short period, was obstinately constipated, and complained of colicky pains and gas in the abdomen; but from the fact that he was jaundiced somewhat, that the tumor could not be separated from the liver and was not movable, that years before he had had an attack of what I judge was acute biliary colic, I made a diagnosis of gall-stone disease with Riedel's lobe; operation revealed impacted cystic duct stone, a Riedel's lobe, and the mass which I misinterpreted was omentum which was infiltrated, attached to and enveloped the gall-bladder and lower border of the liver.

Carcinoma of the transverse colon is so exceedingly rare that confusion with gastric carcinoma of the greater curvature is of seldom occurrence. The gastric symptoms, such as coffee-grounds vomit, the Boas-Oppler bacilli, and the absence of free HCl, and the presence of lactic acid in the stomach contents, need only to be mentioned to differentiate it from stomach cancer; then too the X-ray ought to be an aid, as a case I shall briefly mention will illustrate.

The patient (Mrs. M., forty-five years of age) complained of great loss of weight and rapidly diminishing strength, and a somewhat painful lump about the size of a lemon which appeared in the middle line of the abdomen just above the umbilicus. She complained of no gastric symptoms. On account of the mobility of the tumor mass and the constipation which was present, the idea that possibly a transverse colon carcinoma existed was thought of. The X-ray pictures showed definitely a greater curvature carcinoma and normal colon.

Of course there are cases of carcinoma of the transverse colon that rupture into the stomach and give rise to fecal vomiting, but with the diagnosis of such a condition, inasmuch as it concerns an advanced stage of the disease, we have in this paper nothing to do.

Carcinoma of the splenic flexure I have never personally observed, but Schmidt says the only conditions that can be mistaken for it are carcinoma of the stomach and of the spleen. Here again the X-ray should prove of great assistance.

In malignant disease of the sigmoid where the early pains are referred to the bladder and left testicle, the error of confounding it with nephrolithiasis can obviously be made; but the absence of pathological urinary changes, blood, pus, etc., the negative X-ray findings as regards stone in kidney or ureter, would exclude kidney colic at once.

In this paper I have endeavored to confine myself strictly to the practical side of the early recognition of colon cancer, and if I have digressed somewhat with the recitation of personal cases, it has been with the innocent intention to avoid theoretical discussion and quotations from authorities so called, and to give the results of my own clinical observation.

NON-TRAUMATIC LARGE HEMORRHAGE INTO THE KIDNEY SUBSTANCE OR ITS SURROUNDINGS.

BY RUSSELL STORY FOWLER, M.D.,

OF BROOKLYN, N. Y.

HEMORRHAGE into the kidney substance or in the neighborhood of the kidney commonly follows trauma; but *spontaneous hemorrhage* is so rare as to constitute a surgical curiosity. The etiology of such hemorrhage is found to reside in an arteriosclerotic condition of the kidney, as in Doll's second case; in acute nephritis, as in a case reported by W. H. Dickinson of congestive nephritis resulting from exposure, in which at the autopsy each kidney was found imbedded in a mass of coagulated blood which lay outside the capsule in the surrounding cellular tissue; the hemorrhage was caused by a rupture of the capsule from congestive swelling of the kidney. Rupture in each kidney was at the inferior portion. A tumor of the kidney may cause hemorrhage, as in the case operated by Tuffier, a man of forty who had a hemorrhage into the right kidney from a round-celled sarcoma of the kidney. The case terminated fatally. A fourth cause is found in rupture of an aneurism of the renal artery or one of its branches either before entering the kidney or into the kidney substance. In the *Philadelphia Medical Journal*, May 5, 1900, Keen reported a case of aneurism of the renal artery and gave a résumé of twelve other cases: Titius (S. C.), Gossett, Leudet, Danner, Catalog Museum St. Barth. Hosp., London, 1882, i, 234, Specimen 1636, Armstrong, Turner, Hochenegg, Oestrich (two cases), Grüber, Hahn. Morris, in *The Lancet*, October 6, 1900, reported twenty cases (Hilton, Morris, Rouppe, Danyau, Mounier, Murray, Dourlin) and the thirteen cited in Keen's paper. The case in Morris's paper known as the Reeves case is the same as the Turner case in Keen's paper. The Titius case in Keen's paper seems to be a reference to Nebel's case, the better history being in

Morris' paper. Skillern in the *Journal of the American Medical Association*, January 6, 1906, was able to add five cases (Deaver, Fulton, Abbott, Barnard's first case, and Barnard's second case). Since Skillern's paper but one new case has occurred—Markley, *Medical Council*, Philadelphia, 1909, iv, 225.¹

Of these 26 cases (Keen, Gossett, Oestrich, two cases, Nebel, Armstrong, Markley, Turner, Hochenegg, Grüber, Hahn, Hilton, Morris, Rouppe, Danyau, Mounier, Deaver, Leudet, Danner, Museum Specimen, Abbott, Barnard, two cases, Murray, Fulton, Dourlin) six (Leudet, Danner, Museum Specimen, Oestrich, Abbott, Barnard) gave no symptoms traceable to aneurism, the aneurism being discovered at autopsy; three of these cases (Murray, Fulton, and Barnard's second case) are not completely enough reported to be of value. Ten cases (Turner, Hochenegg, Grüber, Hahn, Hilton, Morris, Rouppe, Danyau, Mounier, Deaver) show hemorrhage into the kidney immediately following severe injury, with recorded kidney symptoms at the time of injury and followed later by traumatic aneurism. In addition are five cases (Keen, Gossett, Dourlin, Armstrong, Markley), in which there was no history of traumatism and in which rupture occurred, which have sufficient data to be of clinical value. In the remaining two cases (Oestrich, Nebel) it is doubtful whether or not traumatism entered as a factor.

A synopsis of Markley's case is as follows:

History.—Male, aged seventy years, pain in the left inguinal region with enlargement of the spermatic cord. First pain had been in the left testicle. Pain increasing. Had had two or three attacks of gravel (?). Pain became rapidly worse. On the second day severe pains in the entire left side. Third day sudden excruciating pain with collapse. Pain over region of the kidney. Died four hours later. Autopsy showed aneurism of the renal artery just outside the kidney, with a deep convexity on the anterior surface of the kidney from pressure. The aneurism extended from the internal inguinal ring almost to the diaphragm.

September 19, 1909, there was referred to me a case which at operation proved to be one of spontaneous bleeding into

¹There has been some question as to the total number of cases reported, Skillern giving the total number of cases as 27 in 1906.

the kidney substance, without any history of injury. The history of the case given below shows that there had been three attacks of lumbar pain similar to the one with which she suffered when referred to me, extending over a period of twenty years. The pathological condition found at operation was so unusual and the clinical picture so striking that no term seemed better to describe the condition than that of apoplexy of the kidney.

T. G., female, aged fifty-two, quite stout, was referred to me September 19, 1909, by Dr. Licht with the following history: Ten days before her admission she had noticed a slight dull pain in the back, which four days later became more severe; she then noticed considerable blood in the urine and several clots. Urination was accompanied by sharp cutting pain in the left lumbar region, radiating to the front of the abdomen and downward to the pelvis. Urination occurred three or four times daily, and the patient was not obliged to get up at night. The cutting pain in the back was worse at night. There was a chill followed by fever. Three days before admission there had been three attacks of vomiting. On the morning of admission the pain became localized to the left lumbar region, and there was considerable tenderness in that region.

The patient gave a history of having had a severe malaria twenty-five years before, lasting for two and a half years. She had had three attacks of lumbar pain similar to the present one, the first 20 years ago, the second 5 years later, and the third 6 years before the present attack. The third attack was the most severe. The history was in other respects negative.

Examination showed a tender, immovable tumor the size of a cocoanut occupying the site of the left kidney. The mass was plainly visible as well as palpable. Temperature, 98°; pulse, 104; respiration, 24. Urinalysis: specific gravity, 1025; color, red; reaction, acid; albumin, a trace; urea, 19 gr. to the ounce; microscopical, an abundance of red and white blood-cells; some hyaline casts; quantity, 45 ounces. Blood examination: hæmoglobin, 95 per cent.; leucocytes, 7800; differential, 75 per cent. X-ray examination negative, no stone discoverable. Permission could not be obtained for a cystoscopic examination, and the patient demanded immediate relief.

Although no history could be obtained of the sudden passage of a large quantity of urine following relief of the pain, and although the X-ray did not show a stone, it was thought probable that the case was one of hydronephrosis associated with calculus. Operation, however, disclosed a very different condition. A six-inch incision in the lumbar region was carried down through the transversalis fascia, and the kidney fat exposed. Immediately on opening the transversalis fascia there was a gush of a small quantity of fluid blood. This was sponged away, and a number of clots, about a double handful, removed from the kidney fat. The kidney fat was separated down to the kidney and the kidney brought up into the incision. There was considerable free bleeding. With the first and second fingers of the left hand pressing the pedicle of the kidney, the organ was examined. It was found that there was a rent in the capsule and in this rent a large clot shaped to the kidney. On account of the hemorrhage it was deemed wise to do a nephrectomy. The tissues surrounding the renal artery and vein were somewhat œdematous, the pedicle was ligated *en masse* with braided catgut. The kidney was removed, the wound cleansed from fluid blood and clots, and as there was some oozing from torn adhesions in the neighborhood of the diaphragm, the entire wound was packed tightly, the end of the packing being led out of the lower angle of the wound. The wound was then closed, except for its lower angle, with layer sutures. The packing was removed on the fourth day and a small strip reinserted, the wound healing *per primam* except at the point of the emergence of the packing. This granulated rapidly. The patient was out of bed on the twelfth day and went home on the eighteenth day. The one untoward symptom noted was some bladder irritation from concentration of the urine; this was remedied by the ingestion of large quantities of fluids and alkalies.

The kidney presents the following appearance: a tear in the capsule through which there had escaped a considerable amount of blood; a partially organized clot beneath the capsule, which had dissected the capsule on the convexity of the kidney loose from the cortex; this shows that the hemorrhage had extended through the rupture of the capsule; a small rupture at the lower pole of the cortex, through which the blood had escaped from the kidney structure; a cavity the size of an egg in the cortex filled with fresh blood-clot; a few small clots in the pelvis of the kidney and in the upper part of the ureter. This, as well

as the presence of blood in the urine, showed that there had been some connection between the hemorrhage in the cortex and the pelvis. Such an opening, however, cannot be made out in the specimen. Dr. Arthur C. Holzman reports the microscopical examination as follows: (1) Section taken from upper pole of kidney away from the blood-clot shows no apparent change in the kidney structure. (2) Section bordering on blood-clot shows, first, the blood-clot, and bordering this, the broken-down structure of the kidney. Passing away from the clot, the normal structure of the kidney is perceived in a state of molecular necrosis apparently from pressure. Here the renal tubules are filled with blood and widely distended, others are collapsed from the pressure of the distended tubules. Still further externally is a zone of tissue, where renal tissue is unchanged except for the tubules which are enormously distended with blood, which passes off into normal renal structure. No-where is there an infiltration of round cells or fibrous tissue. The red blood-cells retain their form and are not broken down. (3) Section of blood-vessel (vein entering cavity) shows an atrophy of the coats. Otherwise no change.

ABSTRACTS OF OTHER REPORTED CASES.

In 1910 Dr. PAUL PICK described a case operated upon March, 1909, by Schnitzler. Schnitzler's case was that of a woman of fifty-three, who, during the menopause, had had violent hemorrhages. Eight years previously she had had an attack of illness with jaundice lasting four weeks, accompanied with violent pains on the right side of the abdomen. For a number of years she had been constipated. A few days before coming to operation, she had become suddenly attacked with violent pains in the right side of the abdomen. These pains were so severe that she became unconscious; she had since had continuous pain. There was no vomiting; the bowels had last moved four days before. Temperature 37.2° ; pulse 72. The patient was of medium size, rather corpulent, of pale complexion. There was slight jaundice. The right side of the abdomen was somewhat distended. Percussion gave normal resonance over the spleen and stomach. Palpation revealed a somewhat enlarged liver; there was marked sensitiveness over the liver; this sensitiveness was more extreme in the right mammillary line below the liver, where there was also felt a resistance. Urinalysis was negative. A clinical diagnosis of cholecystitis was made. An incision over the region of the gall-bladder showed a firmly distended gall-bladder about as large as a child's head, but with no trace of recent inflammation or gall-stones. Exploring further it was found there was an extensive hæmatoma beneath the mesocolon and in the retroperitoneal connective tissue; the abdominal wound was sutured and an incision made in the flank for exploration of the kidney. Upon separating the fatty capsule there was found a large clot surrounding the kidney on all sides. After removal of the clot the kidney seemed quite normal. The origin of the bleeding could not be established. The after course was uneventful except for rather severe infection, necessitating a counter-incision. The patient finally left the hospital cured. Pick makes reference to seven

other cases of a somewhat similar nature. The first reference to the subject is that of Wunderlich in 1856. Wunderlich included in the term "apoplexy of the renal covering," every hemorrhage in the neighborhood of the kidney.

HILDEBRANDT, in 1894, published the first case of perirenal hæmatoma; his case gave the following history: Female, nineteen years old, was suddenly attacked three weeks before with violent pains in the left side of the abdomen. There was considerable shock. The abdomen was greatly distended, and on the left side there was a firm elastic tumor projecting under the costal arch as far as the navel. There was no fever; urine was normal. On incision $1\frac{1}{2}$ quarts of blood and blood-clots escaped. This hæmatoma had completely surrounded the left kidney, which, upon examination, proved quite normal. The wound was drained and the patient was discharged cured after eleven weeks.

DOLL, in 1907, under the name of "Apoplexy of the Renal Covering," describes two cases, both of which resulted fatally without operation. The first case, a man sixty years old, with advanced arteriosclerosis and chronic nephritis, was attacked with colic-like pain in the left kidney region. On the third day of his illness left pleuropneumonia supervened; on the fourth day there was observed an extreme distention of the abdomen, with a large tumor in the left side of the abdomen; on the fifth day the skin in the left lumbar region and the left half of the scrotum became blue; a few hours later the patient died. At autopsy there was found a retroperitoneal hæmatoma reaching from the diaphragm to the bladder; the hæmatoma consisted alternately of masses of fatty matter and blood-clot. Doll's second case was a man forty-one years old, also with arteriosclerosis and chronic nephritis, who was attacked with paroxysmal colic-like pains extending over the entire left side of the abdomen; on the second day a firm elastic tumor was noted in the left side of the abdomen; the patient seemed anæmic; on the fourth and fifth days there was great distention, and the skin over the left renal region became livid; the underlying parts were doughy to the touch. On the fifth day the patient died. Autopsy showed an intraperitoneal hæmatoma lying between the descending colon and wall of the abdomen, and connecting with a retroperitoneal hæmatoma, consisting of fatty matter and blood-clot extending from the diaphragm to the bladder; in the centre of this mass was found a small white kidney *in the capsule of which there was found on the upper pole a small tear*. This led to a small cavity which, as was proven microscopically, consisted of arteriosclerotic kidney tissue.

In 1908 JOSEPH reported a case of spontaneous hemorrhage into the kidney substance, the patient a man of fifty years who had suffered for years with gout. He was taken ill with violent pains in the right side of the abdomen; some days later there was fever and an undefined resistance on the right side of the abdomen; extreme distention followed; the skin overlying the right lumbar region became blue on the sixth day. One year before the patient had had an operation for appendicitis; for this reason a diagnosis of retroperitoneal suppuration due to further trouble with the appendix was made; the patient was operated upon on

the twelfth day. An incision was made in the kidney region and the fatty capsule was removed; septic pneumonia followed and ten days later the right kidney was removed, it being thought that this was the starting point of the sepsis; the following day the patient died. This report lacks adequate pathological description.

Two other cases are reported by LENK as occurring in Hochenegg's clinic. The first that of a girl twenty years old, who was suddenly taken ill with violent pains in the right side of the abdomen; on the sixth day of her illness she was removed to the hospital, and it was noted that she was quite anæmic; the abdomen was distended, there was an ill-defined swelling in the right hypogastrium; urine was normal. Diagnosis of retroperitoneal abscess originating in the appendix was made, and the patient operated upon immediately. A retrocæcal tumor was incised and found to consist of coagulated blood; the cavity extended upward behind the liver. This patient died four days later with septic symptoms. The second case was a woman twenty-eight years old, who had suffered for two years with attacks of pain in the right side of the abdomen; she presented a clearly palpable tumor in the right lower region of the abdomen. Hochenegg removed the fatty capsule, in which were numerous slight hemorrhages, and subsequently demonstrated with the cystoscope and ureter catheterization a hydronephrosis of the right kidney with pronounced impairment of function. This patient left the hospital cured.

It will be noted in remembering the history of these cases of hemorrhage into the renal substance exclusive of aneurism, that with the exception of Doll's second case and the writer's there is no reference made to any communication existing between hemorrhage in the interior of the kidney and hemorrhage into the fatty capsule. In fact, in several of the cases it is noted that the kidney appeared normal (Hildebrandt, Schnitzler), and that the hemorrhage surrounded the kidney. I believe we can therefore say that we have to do with *two pathological conditions*: one arising within the kidney, and later through rupture of the capsule propria involving the tissues around the kidney; the other arising in the fatty capsule of the kidney. Either of these forms may later become so extensive as to rupture the peritoneum and involve the peritoneal cavity. Such hemorrhages as the latter are occasionally seen in fatty tissues of other parts of the body in corpulent people; they follow slight exertion, such as a sudden twist or strain on the part, and have been known to occur when the patient turned over in bed. As an example of this condition of hemorrhage into fatty tissues may be cited

the case of a patient referred to me by the late Dr. J. F. Haller. This patient, an extremely stout man, had been seized with sudden pain over the region of the gall-bladder while turning over in bed; his pain and shock were so intense as to cause a diagnosis of cholelithiasis to be made; when he came under my observation some four or five days later, there was a lack of fever or of any constitutional disturbance. There was, however, a tumor in the abdominal wall overlying the gall-bladder and hepatic flexure of the colon; this mass was ovoid, about the size of the palm, and rather dense; an exploratory incision revealed it to be a rupture of several of the radicles of the epigastric veins, resulting in a hæmatoma. Healing was uneventful.

Symptomatology.—Excluding the cases of aneurism, Tuffier's case of sarcoma and Armstrong's case of congestive nephritis, there remain eight cases (Hildebrandt, Doll's two cases, Joseph, Lenk's two cases, Schnitzler and Fowler) having sufficient data to be of value. Spontaneous hemorrhage either in or about the kidney has occurred three times in males and five times in females; in four cases of young adult life, in three cases of middle age, and one case in old age. It has been associated with jaundice once, with arteriosclerosis and chronic nephritis twice, with gout once, without other diseases four times. In no case was any history of traumatism obtained. In two cases the history definitely states that the patient was fat. The onset of the attack was sudden in all cases, the character of the pain was agonizing in six cases, was less acute in two cases (Hochenegg's second case and the author's case). In all the cases the location of the pain was referred to the half of the abdomen corresponding to the kidney affected. One case gave urinary symptoms—the author's case in which there was sharp, cutting pain in the left lumbar region radiating to the front of the abdomen and down to the pelvis accompanying urination. There was also blood in the urine in this case. In three cases the urine was stated to be normal. In one case there was impairment of function of the kidney affected. In one a mild nephritis; in two a chronic nephritis; in one the urinalysis is not stated.

Shock was a prominent initial symptom in most of the cases though not definitely stated in some cases.

The final location of the pain where mentioned in the history was referred to the lumbar region. Tumor was present in all the cases, though in three it was not well defined, and in one of these latter diagnosis of the location of the swelling was further confused by a much distended gall-bladder.

Extreme abdominal distention is noted in five cases, one not noted, one with slight distention, one no distention.

Anæmia was present in four cases, not present in one case, and not noted in three cases.

Local discoloration of the skin was noted in three cases, absent in five.

Location of the tumor: On the left side below the costal arch, one case; on the left side of the abdomen, left lumbar region and left half of the scrotum, one case; left half of the abdomen and left renal region, one case; right side of the abdomen and right lumbar region, one case; right hypogastrium, one case; right lower region of the abdomen, one case; right upper side of the abdomen, one case; left renal region, one case.

Fever was present in four cases, absent in one case, not noted in three cases. Even where present it was not a prominent symptom before operation.

The symptoms vary according to the severity of the hemorrhage. The course of the attack varies from two days to twenty-six days. In the unoperated fatal cases the course of the attack was five days. There may be slight repeated hemorrhages, as in Hochenegg's second case, or more severe repeated hemorrhages, as in the author's case, extending over a period of from two to twenty years.

Diagnosis.—The diagnosis of hemorrhage into the kidney substance or into the perinephritic fat is difficult if not impossible. Of the cases which we are considering, one was diagnosed as cholecystitis; in two cases exploratory incision was made; no diagnosis in two cases; retroperitoneal abscess from appendicitis in two cases; hydronephrosis associated with

calculus in one case. It is a concomitant symptom of shock or shows interference by pressure on the intestinal nerves.

Urinary symptoms are of no aid except as excluding other lesions of the kidney. In only one case was blood found in the urine.

The diagnosis, if made at all, must be made upon the occurrence of sudden pain in the renal region, associated with tumor and more or less shock, and must be supported by the exclusion of other lesions of the kidney.

Treatment.—Of the eight cases reported six were operated upon, of whom four recovered and two died, a mortality of $33\frac{1}{3}$ per cent. The two cases not operated upon both died.

The technic of the operative treatment will depend on the pathological condition found at the operation. If bleeding is limited to the perirenal fat, this must be excised completely, the hæmatoma removed, and adequate drainage provided. If, however, the bleeding proceeds from the interior of the kidney and has later involved the perirenal fat, not only must the perirenal fat and hæmatoma be removed but a nephrectomy done as well. Thorough removal of the fatty tissues infiltrated with blood-clot is essential, as the post-operative history of these cases shows that suppuration easily follows.

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THE OPERATIVE TREATMENT OF THE DEFORMITY OF POTT'S DISEASE.*

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THE treatment of Pott's disease after the general acceptance of the principles of mechanical support, as demonstrated by Taylor and Sayre, had become practically one of routine, when in 1897 fresh interest was aroused by Calot's advocacy of forcible correction of the deformity.

This, although an ancient practice, and although it had been performed in a fashion by Chipault several years before, was, as far as its practical application was concerned, a new operation. After a very general test it was abandoned, not so much because of its dangers as because it had been demonstrated by autopsy and confirmed by experience that the capacity for bone formation between the separated vertebral bodies was quite inadequate to fill the gap caused by straightening the spine. Thus recurrence of deformity was not only inevitable, but necessary even for repair.

Calot's operation served an important purpose in calling attention to the ineffectiveness of routine treatment, and, although forcible correction was abandoned, greater effort has been made since this time to reduce deformity by milder means and to remove pressure and friction, the most constant factors in the destructive process, by extension and hyperextension of the spine.

My own contribution has been the narrow convex frame designed to correct deformity by gravity, and to hold the spine in hyperextension during the active stage of the disease. This is, in popular speech, the "board" which the photographs of Smiling Jimmy of the Sea Breeze Hospital have made familiar.

* Read before the New York Surgical Society, October 11, 1911.

For ambulatory treatment Tunstall Taylor, Goldthwait and others devised apparatus to apply jackets in dorsal recumbency, while Calot, in his persistent efforts to reduce deformity, made a still more important modification of the plaster support. Better fixation was assured by including the shoulders, neck, and, if necessary, the head, while corrective force was provided by pressure over the kyphosis, the front being cut away to permit the protrusion of the chest as the trunk was pushed forward. Calot has presented photographs showing recession of marked deformity, and although this is unusual, it must be admitted that the Calot jacket is far more effective than ordinary supports, requiring, however, more skill in its application and more careful supervision to make it tolerable.

While it may be stated that, under favorable conditions, by the use of simple means such as the convex frame in recumbency and the Calot jacket in ambulation, deformity may be prevented and even in some degree lessened; on the other hand it must be admitted that, at best, mechanical treatment is tedious and difficult; and that it is ineffective under ordinary circumstances is evidenced by the number of noticeable deformities from this cause, the degree being determined rather by the character and situation of the disease than by the means used to prevent it.

For example, the cervical and lumbar or free regions of the spine are favorable for treatment, and, in the absence of complications, recovery without noticeable deformity may be anticipated. In the thoracic region, on the other hand, the opportunity for deformity is great, and the constant movement of the thorax in respiration makes it difficult to assure the rest essential to repair.

Repair in milder cases is sometimes accomplished by adhesion of the adjoining vertebral bodies, but ordinarily the loss of substance is so great that symmetrical apposition is impossible. In this class of cases final consolidation is sometimes assured by a callus formation, which involves the lateral

masses and even the laminæ and spinous processes remote from the disease.

The object of operative treatment is to induce such consolidation of the posterior part of the spine, in order that it may serve as an effective splint to prevent deformity and to assure the rest that permits repair.

The first operation for this purpose was, it would appear, suggested by Hadra (*Trans. American Ortho. Assn.*, vol. iii, 1891). He proposed to bind the spinous processes of the diseased and adjoining healthy vertebræ to one another by silver wire twisted in figure-of-eight turns, a procedure which had been successfully employed by him in a case of fracture.

A similar and more comprehensive operation, in that deformity was first corrected and the adjacent spinous processes denuded and afterward bound to one another by silver wire, was later described by Chipault in 1893.

Recently F. Lange, observing the toleration of the tissues for silk, metal, and other foreign substances, has attempted to replace external support by internal splints, which being independent of the patient's control should be more efficient. He found tin plated steel to be the best material, and in the one successful case which he reports in detail the procedure was in brief as follows: The splints were of tin plated wire, 10 cm. long and 5 mm. in thickness. Incisions were made through the skin and fascia, corresponding to the upper and lower ends of the splints, which were then inserted beneath the muscles close to the spinous processes, on either side of the diseased vertebræ, the bulbous extremities being attached to the spinous processes by silk to retain them in position. A Calot jacket was applied with an opening to prevent pressure. This was replaced in six weeks by a celluloid corset worn constantly for six months, when, the patient being free from pain, it was gradually discontinued.

The operation was performed about two years before it was reported in 1910 (*Journal American Ortho. Assn.*, Nov., 1910). The patient was a boy about twelve years of age, the disease at about the tenth dorsal vertebra. Pain was immedi-

ately relieved and the progress of the deformity was checked. After the support was discarded the boy served as a helper to a blacksmith. The metal splints remained in position, holding the diseased section of the spine securely. Lange considered the transplantation of bone, but because of the additional injury to the patient in autoplasmic transplantation and because of the difficulty of obtaining suitable material from other subjects at the proper time, he preferred to experiment with metallic supports.

Another form of operation on the lines of that of Chiapault, but in a more effective form, has been described by R. A. Hibbs, the design being to induce adhesions between the spinous processes and at the same time to lessen the prominence of the kyphosis (*N. Y. Med. Jour.*, May 27, 1911). An incision is made along the spinous processes, the interspinous ligament is split and separated with the periosteum to either side. With a chisel the base of the spinous process of the sound vertebra above the diseased area is cut through, and the operation is repeated on the spinous processes involved in the disease, including finally the sound one at the base. Each spinous process is then displaced and tilted downward so that, while a part of its base is still in apposition with the surface from which it has been displaced, its tip is brought into contact with the upper part of the area from which the spinous process of the vertebra below has been separated. The tissues are then sewed over the fragments and a support is applied.

This operation was first performed on December 27, 1910, and has been repeated on two other patients. In the first case an X-ray picture taken three months after the operation shows consolidation of four spinous processes, the disease being at the second lumbar vertebra. All support had been removed on April 5 or about three months after the operation. Hibbs suggests that supplemental bone grafting from the tibia might be necessary to secure consolidation in younger subjects.

In an article appearing recently (*Jour. Amer. Med. Assn.*,

Sept. 9, 1911), F. H. Albee reports three cases in which bone taken from the tibia was transplanted to one side of the spine. The spinous processes overlying the disease were split longitudinally to the lateral side of the centre. The lesser section was separated laterally, leaving a wedge-shaped interval into which the bone graft was placed. The first operation was on June 11, 1911, the last on July 14. The report was apparently made soon after, consequently no further details, except that primary union was obtained, are given.

In considering operative treatment it has seemed to me that it should be especially indicated in early cases of disease in the thoracic region, in which the deformity might be easily corrected with but slight separation of the vertebral bodies; that Lange's method was mechanically the best, but that the metal splints should be replaced by bone of sufficient strength to serve as an immediate support, and which in process of absorption might stimulate a callus formation from the neighboring parts similar to that found in the natural cure.

The patient who first offered a favorable opportunity for a test of the treatment was a boy nine years of age, who was admitted to the hospital because of a pressure sore caused by a plaster jacket. The disease was progressive as evidenced by pain, muscular spasm, and lateral distortion of the body. There was a moderate degree of angular deformity, which was sufficiently flexible as to indicate that there had been no progress toward repair.

On August 11, 1911, the ulcer over the kyphosis being closed, the operation was made as follows: The entire length of the crest of the tibia was exposed, and a thick, strong section of its anterior part, six to seven inches in length, was separated with the chisel. This retained the periosteum intact on its upper surface and the endosteum on its lower, the medullary cavity of the bone being completely exposed. The tibialis anticus muscle was drawn over the gap, the skin was sutured, and a plaster bandage was applied.

An incision about four inches long was made a little to the right of the median line over the diseased area, and the muscles

were separated on either side from the spinous processes and lateral masses, the tissue was removed from between the spinous processes, and the bony surfaces in the neighborhood freshened. The tibial bone was then cut into two equal parts, and the spine having been forcibly straightened, these were inserted by the side of the spinous processes with the periosteal surface uppermost. The muscles were sewed over the grafts and the wound was closed. A Calot jacket was applied and to its contour a convex stretcher frame was adjusted.

The patient, after an uneventful period of five weeks, died six weeks after the operation, apparently of tuberculous meningitis. This complication is relatively so common in all forms of tuberculous disease in children, according to the statistics of this hospital no more so in those who have been subjected to operation than in those who have not, that it is impossible to say whether or not the treatment hastened the outcome. Unfortunately, no autopsy or even examination was permitted. All wounds were closed and the bone grafts were firmly fixed, supporting the spine in the corrected position.

In the literature of the subject but two positive observations appear: (1) that in Lange's case metal splints were tolerated for a period of two years, and that they served the purpose for which they were used; (2) that in one of the cases reported by Hibbs, ankylosis between the spinous processes of the lumbar vertebræ was secured, and that this union was sufficient to support the spine. Furthermore, it is sufficiently established that the tissues will tolerate transplanted bone, which may serve a temporary purpose as a support and, in the process of absorption, stimulate the reproduction of bone from the adjacent tissues.

Bone transplantation from the same individual is usually more successful than from other subjects. Grafts are usually taken from the tibia for obvious reasons. Possibly sections from the ribs, as suggested by Dobrotworski (*Zeits. f. Chir.*, Aug. 12, 1911), might be equally serviceable.

As has been suggested, the operation seems to be especially indicated in disease of the thoracic region in which the

deformity may be easily corrected. In this class of cases the tissues are so thin that the bone splints should be buried beneath the muscles to avoid the danger of pressure necrosis.

The procedure followed by Albee does not appeal to me, as the implanted bone is too superficial and is unsymmetrically placed.

Hibb's operation, which lessens the direct deformity and which has, in the reported case, induced ankylosis, might be with advantage combined with transplantation.

At the present time operative treatment is in the experimental stage, and its actual value can be determined only by years of observation. This point of view and the exigency of this occasion will excuse the inconclusive report that has been presented.

MODIFIED AUTOGENOUS GRAFTING AND TURN- ING SKIN FLAPS TO COVER GRANULATING SURFACES.

REPORT OF EXTENSIVE BURN PRESENTING UNUSUAL FEATURES.

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AND

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THE case reported below, while probably not unique, presented many uncommon features. The methods employed are also not strictly original, but differ considerably from the usual methods employed in such cases. The case is not the only one which has been treated by the methods described. It has been selected from 35 cases which have been under treatment for similar conditions during the past seven years, because it illustrates especially well the value of the modifications of usual methods described.

The patient, H. E., aged twelve years, threw gasoline on a bonfire in August, 1909. His clothing caught fire and he was badly burned over the areas marked in the photograph. With the exception of scattered spots on the buttocks and arms, the burns were of the second and third degree. In a hospital near his home, some weeks after the injury, large Thiersch grafts were taken from both thighs of the patient. These grafts failed to take, and he was left with large suppurating areas on the thighs in addition to the burned surfaces. At the same hospital, a like attempt was made with grafts taken from his father with the same result. The first of January, he was brought to the Ithaca City Hospital. At that time his condition seemed hopeless. He was very thin and anæmic; appetite and digestion poor; temperature ranging above normal; so weak that he had been confined to bed for over three months. The raw areas were

badly infected, discharging pus freely and covered with sluggish granulations.

Our first efforts were directed to building up the boy's health and strength by general hygienic, dietetic, and tonic measures, and to get rid of as much of the infection as possible. All the milk and eggs he could take, raw beef juice, 12 oz. a day, plenty of fresh air, nux, quinine, and iron were the general measures used. Moist weak bichloride of mercury dressings were applied locally and changed daily. Under this treatment, he gained considerably in weight and strength, the hæmoglobin percentage rose, and the granulating surface became cleaner.

Deeming him too weak to stand autogenous grafting, grafts were taken from others. Seventeen attempts of this kind were made, the grafts being taken from fifteen different individuals. In every case the grafts did well at first and remained in seemingly good condition for about three weeks, when in the course of a few days they would disappear, leaving no trace. Both Thiersch and Wolf-Krause grafts were employed with equally complete failure.

As a last resort, under local anæsthesia, long, tongue-like flaps were cut wherever possible and turned into the burned area, being left attached to normal skin by a narrow pedicle. This procedure proved entirely successful and the epithelium rapidly covered in the areas between the flaps. Flaps were turned nine times; two flaps on three occasions, only one at other operations.

Of necessity the application of this method was limited and we now turned to small autogenous Thiersch grafts. The technic employed was as follows: Over a portion of the granulating area, the granulations were curetted away or trimmed down. Gauze moistened in 1 to 4000 adrenalin chloride solution was laid over the areas so treated. This controlled hemorrhage very satisfactorily. The area from which the grafts were to be taken was then prepared with ether and alcohol, and parallel lines of infiltration with 1:500 novocaine solution were made. Along these lines narrow strips of Thiersch grafts were taken. These strips were cut into small pieces. The denuded area was dressed with a thick layer of sterile vaseline spread on cotton flannel. Small pieces of the grafts were then applied

to the raw surfaces rendered dry by the adrenalin chloride solution. They were dressed with gauze wrung out of saline solution, over which was placed oiled silk. Because of the large amount of discharge from the granulating area, the gauze was moistened every four to six hours and changed every twenty-four hours. Later on when a rather severe infection with *Bacillus pyocyaneus* occurred, the gauze was moistened with a 1:10,000 bichloride without perceptibly influencing the grafts or the infection. Careful and thorough cleansing of the skin about the granulating surface seemed to be the most efficient means of controlling the infection, and its influence varied directly with the conscientiousness of the individual doing the cleansing.

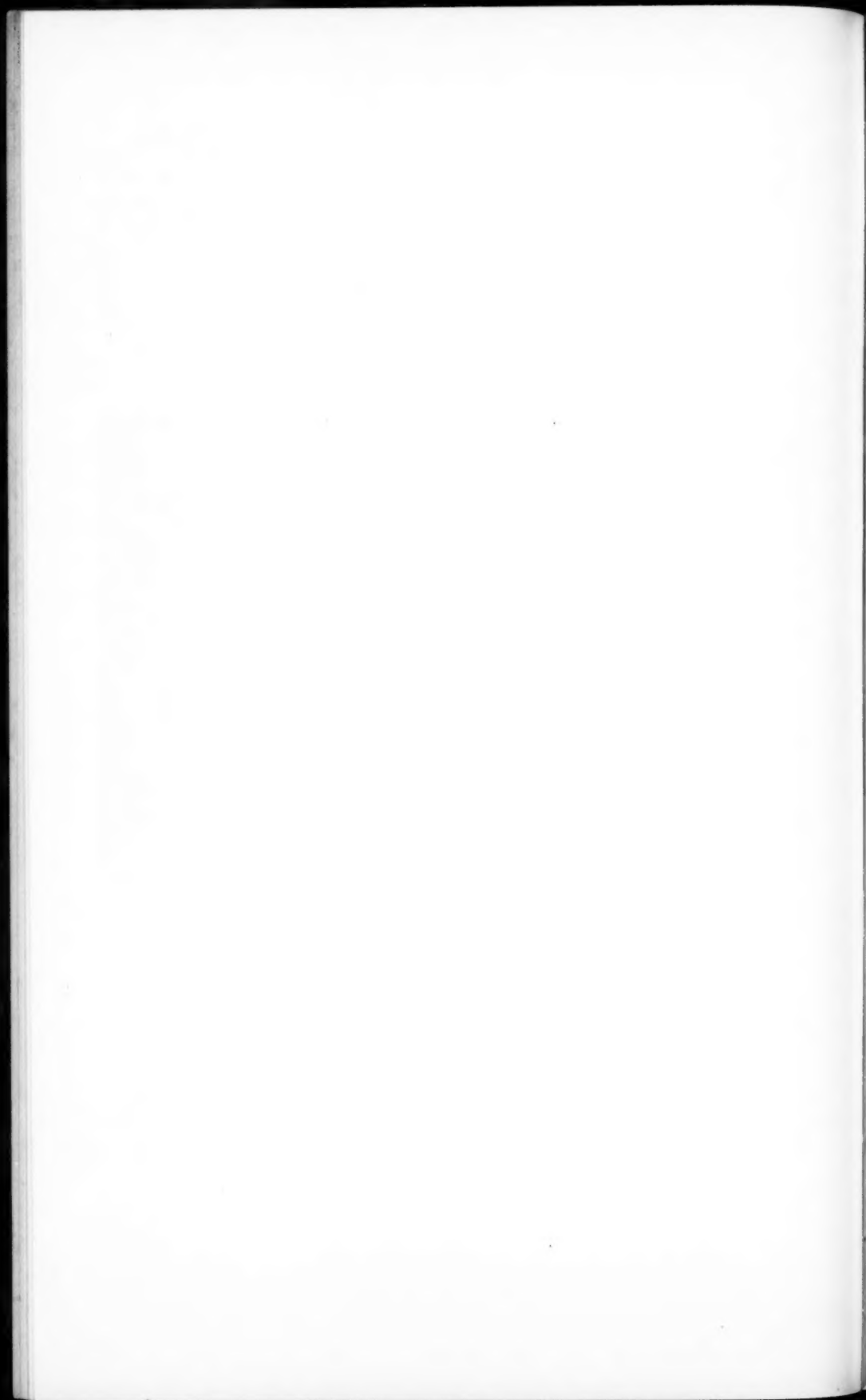
The modified Thiersch grafts managed in this way were uniformly successful and the patient left the hospital entirely healed on December 24, 1910.

In April, 1911, we decided to try to approximate the extent of the area originally uncovered by skin. Of necessity it was an approximation. The area of the scar is considerably less than that of the original denuded area. Spaces between the flaps turned in, which were at that time 2 to 2½ inches wide, are now from ½ to ¾ of an inch wide. Any one with much experience in burn cases realizes the extent to which contraction takes place.

The scarred areas were divided into approximate parallelograms and triangles and the surfaces estimated in that way. The figures thus obtained were 3075 square centimetres (about 500 square inches).

The total skin area of the human body is variously estimated. Vacher gives 10,500 to 15,000 sq. cm.; Wilmart, 16,400 to 18,700; Lefevre, 14,500 to 15,000; Bordier, 16,717 to 19,445 for men 5 ft. 9 inches in height. Sappey, working with six average sized adult men, puts the figures at 15,000 sq. cm.; the average adult woman, 11,500 sq. cm. The boy in this case was twelve years old at the time of his accident, a little over 5 feet tall and weighed between 70 and 80 pounds. At the time he left the hospital in December, 1910, he weighed 98 pounds. Considering his size as related to that of the average adult male, it would seem that 9000 sq. cm. would be a high figure for his skin area.





With a scar measuring about 3075 sq. cm. it seems certain that in this case there was well over one-third of the body area denuded of skin at one time.

This case has seemed to us and many other physicians who followed the progress of the boy to be of unusual interest for many reasons.

The denuded surface was unusually large to be followed by recovery. The older text-books all estimate that a burn involving more than one-third of the body surface is almost sure to be fatal. The careful estimates given above show that this area was very much exceeded in this case.

A second point of great interest and value was the complete failure to get any results from heterogeneous grafts. In many cases of skin grafting, heterogeneous grafts taken from one person will fail, while those taken from another will "take" successfully. In this case, 17 attempts were made with heterogeneous grafts taken from 15 different persons and with ultimate failure in every instance. Of further interest in this connection is the fact that primarily every one of these attempts promised to be successful. Almost all of the grafts adhered well, and in most cases seemed to be spreading and covering in the raw surface nicely. The improvement would continue for about two and a half to three weeks. In several cases, the grafted surfaces seemed to be entirely and permanently covered in with the heterogeneous grafts and the epithelium which spread over the raw edges. But at the end of about three weeks, the grafts began to fade slowly and apparently dissolve away like ice in water, again leaving a raw surface. The results for the first two or three weeks were in every case encouraging. The disappearance of the grafted skin is probably caused by a process similar to hæmolysis. The grafts and epithelium disappeared in the same way that the blood-corpuscles disappear in many cases of blood transfusion. A further study of this condition would seem to be desirable and to promise much of scientific interest.

A third point demonstrated to our satisfaction in this and in a number of other cases is that it is unnecessary to scrape off the granulation tissue in preparing the surface for grafting. The granulations need be simply trimmed down a little with scissors curved on the flat. This gives very much less bleeding than entirely to scrape away the granulations as was tried on several occasions. The results were as good when the granulations were simply trimmed as when they were entirely scraped away.

A fourth point which has been mentioned by other observers is that the autogenous grafts do well in spite of infection. The attempts to get rid of infection in this case have been already mentioned.

A fifth point that we have not seen mentioned in this connection is the use of a gauze sponge saturated with diluted adrenalin chloride solution applied immediately to the freshened surfaces to arrest oozing. In this way a very considerable amount of blood was saved.

Sixth, we would again call attention to the fact that both the thin Thiersch grafts and the full thickness Wolf-Krause heterogeneous grafts were unsuccessful.

Seventh, an unusual feature deserving emphasis, it seems to us, was the turning in of flaps to cover the raw surfaces. The advantages of turning in flaps were several: (1) It did not create any further raw surfaces; (2) there was much less loss of blood than when a surface of any considerable size was grafted. Both of these points were matters of great importance in the case of a boy so weakened, anæmic, and septic. (3) Such flaps proved certain to grow if properly used. (4) Ultimate results were much better than if grafts alone had been employed. The peninsulas of normal skin formed by turning in flaps give less scar-tissue contraction, for these strips of normal skin soon become naturally elastic and also have normal sensation.

Of great importance seems to us the use of local anæsthesia. In this case it seems highly improbable that the boy could

have recovered had general anæsthesia been given to him repeatedly for small operations, and he almost certainly would not have recovered had an attempt been made to cover the entire surface or any large portion of it by one operation at first.

There are undoubtedly many less serious cases of burn or injury in which a similar procedure would be advantageous. Very many patients come through a long and tedious convalescence, attended by much pain and considerable risk to life from septic poisoning, who could be promptly healed by this method of skin grafting under local anæsthesia with or without turning flaps as described. The conclusions given have been reached after a good deal of experience in handling 35 cases of this kind. The case described was selected as a text simply for the reason that the conditions illustrate especially well the difficulties usually met in such cases and a possible successful solution of the problem.

A NEW CONTAINER FOR STERILIZED OPERATING SUPPLIES.

BY KARL CONNELL, M.D.,
OF NEW YORK.

Instructor in Surgery in the College of Physicians and Surgeons, Columbia University;
Second Assisting Surgeon, Roosevelt Hospital.

EVERY device that simplifies the handling of the operating room supplies is a step toward absolute asepsis as well as toward economy of energy. The new container here described is such a device, and since it is adapted to a single operation it has been called the "unit shell." It consists of a large longitudinally split cylinder assembling in one receptacle the dry goods needed for one operation, easily packed, and effectively sterilized and stored. It is simple, convenient, and time saving in the operating room.

The day of the many small package system in hospital practice passed when it became possible to sterilize large bundles by vacuum exhaustion and steam under pressure. This advance simplified the technic. Preparing and opening a few cloth- or paper-covered bundles was found quicker and safer than handling many.

The next step in advance was the use of a large drum-shaped metallic container. This drum was more economical of space in the sterilizer, less exposed to contamination during storage, and more readily accessible to the clean operating room attendant than any package hitherto devised. The best types were of copper, with holes in the side which were open during sterilization and closed immediately thereafter by a sliding band. These were designed to stand on a skeleton frame in the operating room with an arm to engage the lid and open the same when desired, by a foot pedal. Usually a full operating room equipment was contained in three or four drums. Into these the nurse plunged for supplies with sterile

forceps. This type of container has been widely accepted, and is a great step toward asepsis and economy of energy.

The defects in this type, as met with in the writer's observation of hospital work, are partly mechanical. The sliding bands become dented and jammed, the lid loosened, the single hinge bent, and the closure untrue. The holes are many, and closure of all holes is frequently not effectual; either the sliding band is defective or else the contents get jammed in a hole and become contaminated unobserved. Also machinery is needed to operate the lid, a lever, a foot pad, and counterweights. As the foot pedal requires a strained posture on the part of the nurse, it wastes time when the saving of an instant may be important. Also, if the unused contents are to be carried over to a succeeding operation, they must be handled only by sterile forceps, another waste of time and energy. Most important, the contents are subject to contact-infection from one case to the next through accidental use of unclean forceps and hands in stress of emergency, and many surgeons, realizing this danger, assign the most highly trained operating room nurse to attend the pedalling and doling out of the clean goods, thereby losing her from the operative field.

To preserve the advantages and to obviate the defects of the present metallic containers, the writer devised for the Roosevelt Hospital the new type of container now to be described. It has been tried out under adverse conditions, night emergency cases, and shifting nursing corps, etc., and has been found to meet every requirement.

The container as shown in the diagram (Fig. 1) consists of a longitudinally split copper shell, opening along the back on a strong rolling or piano hinge, into two equal halves, making when open a flat table, as it were. It closes by a single overlapping engaging joint, into a dust-proof cylinder of appropriate size to fit a sterilizer. For a 16 inch sterilizer it is $14\frac{3}{4}$ inches in diameter over all, and is 18 inches long.

The shell is planned to carry an excess of all the operating supplies required at any operation, towels, all sizes of wipes, pads, dressings, cotton and bandages, glassware, safety pins

and drainage tubes, rubber goods, etc., as experience dictates sufficient for any extensive operation—in fact, everything except dishes, instruments, suture material, and surgeon's attire. The routine of packing is indicated by written schedule, so as to properly apportion the amount of contents and to place them where they can be found conveniently. The goods of each half are enveloped in a thin muslin cover, which can be thrown back to drape the edge of the opened shell, are covered by a towel, and are held in place by a detachable wire mesh cover.

The shell is then partly closed and so clasped as to leave open a half-inch slit, and is subjected to the usual sterilization (Fig. 2). Steam penetration is very effectual, since an entire slit is open instead of a few small holes as in a drum, and the steam has direct access to the deep interior of the package. The exposed surface to steam and to drying in the unit shell is 504 square inches, against about 12 square inches in the old type of drum.

Immediately after the completion of sterilization and drying, the shell is taken out, the clasps are closed, sealing the contents, lock pins are inserted, and the shell is stored for use.

The advantages to be noted thus far are, a durable shell with few working parts not readily to be damaged by mishandling, a strong rolling hinge, and overlapping engaging joint ensuring accurate closure, also effective exposure to steaming and drying in the sterilizer, and a dust proof and locked closure of the single joint of the container during storage.

When to be used, the shell is placed on a stand by a non-sterile attendant, and opened flat, making a table 18 inches by 28 inches (Fig. 3). The two wire meshes are removed by a sterile attendant, the muslin covering thrown back, draping the sides of the table and exposing the towel covered contents, accessibly arranged. This entire procedure consumes only thirty seconds, and in addition to being a great economy of time and energy, eliminates possible oversight in laying out necessary supplies and the danger of contact-infection which

FIG. 1.

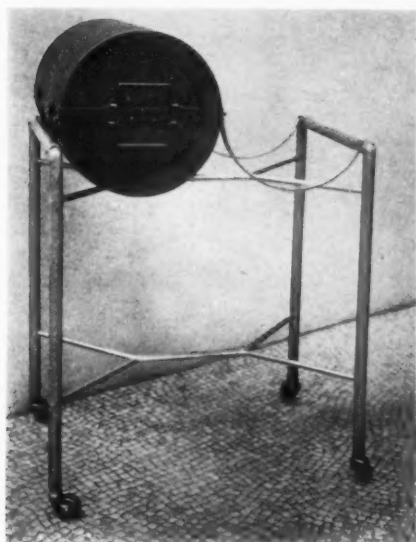


FIG. 2.

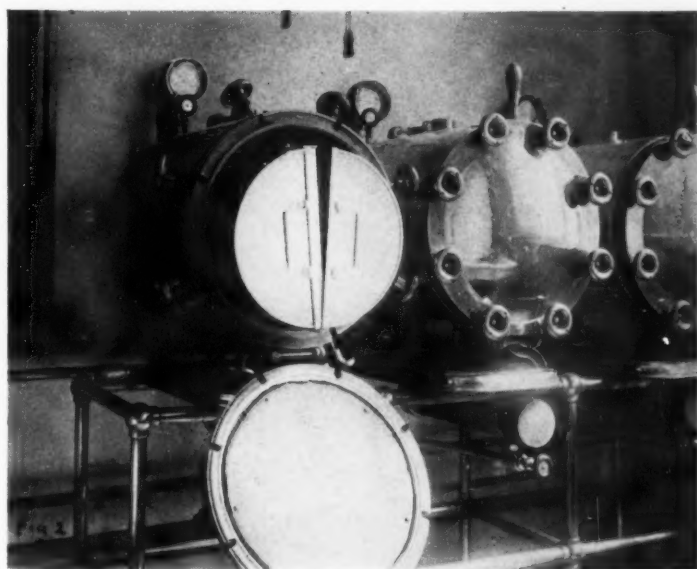


FIG. 3.

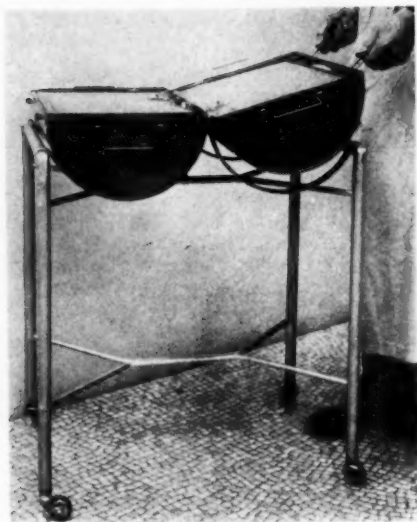


FIG. 4.



attends the opening of each package in the multiple package system. The most skilled nurse need not be assigned to handling supplies, as is the case with the present drum method, for none of the excess contents will be used on the next case and the goods are well protected against extraneous contact-infection.

Much waste motion of the drum system is saved by the use of the hand instead of the forceps, and by elimination of the pedal and machinery. This saving totals in the shell system five seconds on the average for each article secured, as over the drum method under like conditions. The goods are also accessible over a wider area, 504 square inches in the open shell against 308 inches in two opened drums of the same total capacity, thus rendering the individual objects more readily found in the shell system.

At the completion of the surgical operation the shell is closed and removed from the operating room and a fresh shell placed for the next operation. The used shell can be removed and a new clean equipment of goods opened and accessibly arranged for the next operation in less than one minute.

After removal from the operating room, the shell may be replenished from stock within a few minutes and is ready to be sterilized for future use.

While the capacity of the container is limited, the apparent inelasticity of the contents is minimized by experience in packing. An excess of those goods which may meet an unusual demand is packed as a routine. Nor does this excess mean any waste in material or in labor, for it remains in the shell and is merely added to in repacking. Rubber drainage tubes and such perishable goods are renewed when deteriorated, or about every tenth sterilization, providing they have lain unused so long. The remaining cotton goods are moved toward the top in repacking, so as to become browned by many resterilizations. Occasionally, however, goods will run short in some extensive operation and a new unit must be opened. This is as quickly done as opening a small package. Minor operations may be handled by packing each half of certain

shells as a separate unit, opening one side as required for each operation.

The advantage from a stand-point of asepsis of a fresh unit for each case is so apparent as to need no comment.

In conclusion the "unit shell" offers a mechanically strong, dust-proof container, more effectively exposed to steam and to drying than any metallic container hitherto devised. It is capacious, simple, and safe in handling, is time-saving in preparing for and during an operation, and ensures in the simplest and speediest manner a clean, new equipment for each succeeding case in the stress of a busy clinic.

TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY.

Stated Meeting, Held at the Hospital for Ruptured and Crippled, October 11, 1911.

The President, DR. CHARLES L. GIBSON, in the Chair.

FRACTURE OF THE NECK OF THE FEMUR TREATED BY THE ABDUCTION METHOD.

DR. ROYAL WHITMAN presented several patients who had been treated by the abduction method for fracture of the neck of the femur. The cases illustrated the two types of fracture of early life: first, at the epiphyseal junction, which was most common during adolescence in weak and over-weighted subjects. The injury was often slight, and as the process of separation was frequently gradual, the patients, usually, were not brought for treatment until months later, then for supposed disease.

In recent cases the displacement might be reduced by abduction and inward rotation, but if the fragments were adherent, an open operation was required in order that they might be separated and replaced in normal position.

In the second class of cases the fracture was similar to that in the adult, and was caused by direct violence. In all of the cases a functional cure had been obtained.

Dr. Whitman also presented a woman, seventy-four years of age, who had been treated by the abduction method for intra-capsular fracture. The bone had united without appreciable deformity, as demonstrated by an X-ray picture. The patient was able to walk with ease, although a slight limp persisted. This type of fracture directly involved the joint in the injury, as well as in the process of repair, and although perfect function might be restored in favorable cases, it could hardly be expected in aged subjects.

Dr. Whitman said the abduction method was a means of

applying surgical principles, namely, reduction of deformity and fixation of the fragments—principles that had heretofore been disregarded in the treatment of this type of fracture.

THE OPERATIVE TREATMENT OF PARALYTIC CALCANEUS.

DR. WHITMAN showed a number of cases illustrating this condition. In deformity of this type, in which the resistance was lost by paralysis of the calf muscle, the foot atrophied, the gait was insecure, and the distortion was progressive.

The design of the treatment was to substitute the stability of bony contact for muscular tension. The astragalus, the centre of anteroposterior and lateral distortion, was removed through an external incision. The foot was then displaced backward so that the tibia was brought into direct contact with the navicular. If the peronei muscles were active, they were transplanted into the tendo Achillis. Cavus was then reduced, lateral deformity was prevented by the malleoli which clasped the foot at its base, dorsal flexion was prevented by contact of the tarsus and the tibia, and a useful foot, which would support weight without the aid of apparatus, was assured.

This same procedure, Dr. Whitman said, was of service in cases of complete paralysis, the so-called dangle foot, and might be substituted with advantage for arthrodesis. One case of this kind was shown, the operation having been performed on both feet. The patient walked well without support, and there had been a very appreciable restoration of muscular power, which had before been latent.

ARTHROPLASTY FOR BONY ANKYLOSIS.

DR. WHITMAN showed three of these cases. The first patient was a woman suffering from chronic polyarthritis of the atrophic type. The left elbow was exposed by a posterior cross incision, and the upper half of the olecranon was removed. The lower extremity of the humerus was removed in a curved line, with the convexity uppermost; the remainder of the olecranon was then hollowed out to a thin shell of cortical substance, and the head of the radius was cut away, leaving a wide interval between the opposing surfaces, over which fascia was sewn. The triceps tendon was then stitched with silk to the upper end of the olecranon.

A similar operation to this was performed on the second patient, a boy nine years of age, for ankylosis following scarlet fever. Both operations had been done within a few weeks, and

passive movement was to be deferred until a sufficient time had elapsed to permit repair of the denuded surfaces. It was thought that the wide interval between the bones would effectually prevent union.

The third case was one of ankylosis of the wrist with flexion deformity following infectious arthritis. In this instance a section representing the first row of carpal bones was removed, and the deformity corrected. This operation was done two weeks ago.

EPIPHYSEAL FRACTURE AT THE UPPER EXTREMITY OF THE HUMERUS.

DR. WHITMAN showed this case to illustrate a perfect functional cure of epiphyseal fracture and displacement of the upper extremity of the humerus. The patient was a boy, eighteen years old, who had been treated six years before. The treatment was an adaptation of the abduction method used so successfully for fracture at the hip-joint, the principle being to adjust the long fragment to the small and uncontrollable fragment. The displacement was first reduced by abduction and rotation of the humerus. The fragments were then held in apposition by fixing the arm in abduction, with sufficient forward inclination, by a shoulder plaster spica, either in right angular abduction or by elevating the arm to a nearly perpendicular attitude. The method was also of service in the treatment of other fractures in the vicinity of the joint.

THE SHOULDER PLASTER SPICA.

THIS was illustrated by a patient who had been treated by open operation for fracture at the elbow. It was very serviceable whenever it was necessary to hold the arm in an extended position because of lateral deformity at the elbow. The entire limb, to the extremity of the fingers, was inclosed in the plaster bandage, which included the shoulder and the thorax, holding the limb in an elevated position and thus preventing the congestion and œdema that the extended attitude induced when the arm was dependent.

THE TREATMENT OF DISEASE OF THE HIP-JOINT BY ARTHRODESIS.

THE patient was a woman who was admitted to the hospital for deformity and pain, which had persisted for more than a year. Her symptoms were caused, apparently, by an infectious arthritis. She had been previously treated for sciatica.

The joint was opened through an anterior incision and the upper third of the head of the femur was removed, together with a section of the upper part of the acetabulum, after the method suggested by Dr. Albee. The limb was then fixed in extension and abduction. According to Albee's diagram, the denuded surfaces were brought together by abduction, but if the joint was, as in this class of cases, fairly normal, no such contact was possible, and as in this instance, the interval must be filled by new bone formation to assure ankylosis.

BACKWARD DISLOCATION AT ELBOW.

THIS patient, a boy nine years old, had been treated for several weeks before admission to the hospital for supposed fracture. The joint was opened by a posterior incision and the dislocation was reduced. The operation was done three weeks ago, and perfect function was expected.

EXTREME TALIPES EQUINO VARUS.

THE patient, a boy, nineteen years of age, came under Dr. Whitman's observation six months ago for a deformity which had been caused in early childhood by a cut with an axe which had severed the dorsal flexors of the foot.

At the first operation, the varus had been overcome by wrenching, and the contraction of the toes by tenotomy of the flexor tendons. Three months later, the equinus was overcome by force and by division of the tendo Achillis. The correction had been aided by constant use of the foot, which had been fixed in plaster during the treatment, and the patient had lost but two days' work in the interval. He now wore an ordinary shoe and walked without a limp. The long disused muscles were rapidly recovering functional ability.

A METHOD OF CORRECTING FIXED SCOLIOSIS.

A number of patients were shown by Dr. Whitman to illustrate this method, which was devised by Dr. E. G. Abbott, of Portland, Me. In the treatment of other deformities it was generally recognized that correction and over-correction was the first essential, after which the improved position might be retained by increasing the muscular strength and control.

In this deformity the attempt had usually been made to train

the muscles with the aim of correcting or lessening the distortion, or to apply braces to prevent an increase of the deformity already present. Correction, forcible or otherwise, had been attempted while the spine was extended or even hyperextended. The essential difference of the Abbott method was to flex the spine in order to remove all tension before attempting to correct the lateral deformity and the rotation incidental to it.

The patient was placed upon the back in a narrow hammock in a rectangular frame of gas pipe, provided with an adjustable extension for increasing the forward flexion of the body. The trunk was then drawn laterally and twisted in the reverse direction of the curvature, and a plaster support was applied. Later, a large opening was made over the flattened side of the chest to permit expansion under the influence of forced inspiration. The treatment was repeated at intervals, until, if possible, over-correction was attained.

The immediate results in the cases under treatment encouraged the hope that this was a practicable method of overcoming deformity in this intractable class of cases.

FRACTURE OF THE HIP TREATED BY THE ABDUCTION METHOD.

DR JOHN B. WALKER presented a woman, twenty-six years old, who slipped and fell, fracturing the neck of the femur. On the following day a long side splint was applied without extension. With this she was confined in bed for twelve weeks. She left the hospital on crutches and was obliged to continue their use during the following eighteen months, for no union was present. Two years after the original accident she entered Bellevue Hospital. When standing with the aid of crutches the left lower extremity hung apparently helpless; the glutei and other muscles of this thigh were moderately atrophied. Measurements showed 6 cm. shortening, confirmed by a radiograph, which showed the great trochanter to be displaced far upward.

Treatment was at once begun by applying a Buck's extension with fifteen pounds weight in order to reduce the shortening if possible. The weights were very gradually increased up to forty-five pounds. At the end of six weeks the continuous traction had diminished the shortening to 3 cm. An operation was now performed to bring the separated fragments together and secure them in apposition.

An incision beginning 2 cm. below the left anterior superior spine was extended downward and backward to the posterior margin of the trochanter and then vertically down the thigh, the soft tissues were divided, the capsule exposed and divided, exposing the fracture which had occurred, roughly, transversely through the femoral neck, the proximal fragment consisting of the upper third of the femoral head. Considerable callus was removed, and the fractured surfaces were freshened by the rongeur. By traction and abduction the freshened fragments were brought together with great difficulty.

A steel drill was passed through the great trochanter, the neck, the head, and into the wall of the acetabulum, thus spiking the fragments firmly together. The wound was closed with a small rubber tissue drain. A plaster spica was applied from the lower border of the ribs to the toes.

The wound healed uneventfully; the patient was confined to bed for eight weeks. Four weeks later a Thomas hip splint was applied and she went about on crutches, discontinuing the splint at the end of one year. Five months after the operation, the drill, which was loose, was easily removed by small forceps.

Two years after the operation there is some motion at the hip. Less than 2 cm. of shortening exists. She walks without a cane, is free from pain, and is supporting herself by doing regular work.

THE OPERATIVE TREATMENT OF THE DEFORMITY OF POTT'S DISEASE.

DR. ROYAL WHITMAN read a paper with the above title, for which see page 841.

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ANNALS OF SURGERY,
227-231 South Sixth Street,
Philadelphia.

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Vol. LIV

DECEMBER, 1911

No. 6

ANNALS OF SURGERY

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A Monthly Review of Surgical Science and Practice.

Edited by LEWIS STEPHEN PILCHER, M.D., LL.D., of New York.

WITH THE COLLABORATION OF

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OF PHILADELPHIA.

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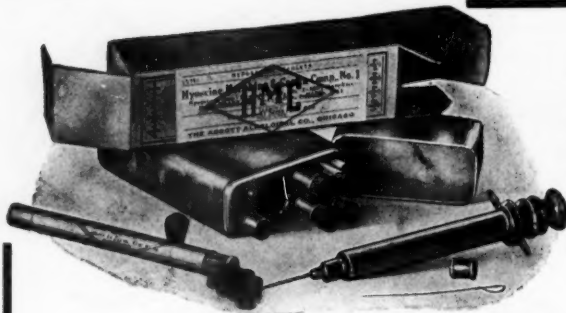
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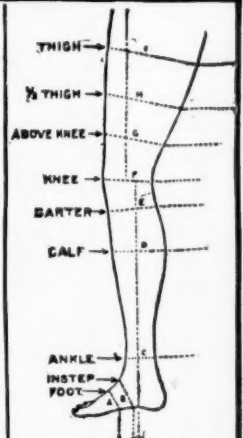
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By Minna Irving

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Said Papa Vanderveer.
"I've thought of every blessed thing,
From furs to lingerie,
But nothing that she hasn't got
Suggests itself to me."

He bought a magazine, the ads
With interest he eyed,
"A motor-car, the very thing!"
Delightedly he cried.
So when the bells of Christmas pealed
Across the frozen drifts,
One maiden found an auto-car
Among her Christmas gifts.

THE CAR IN COLD WEATHER

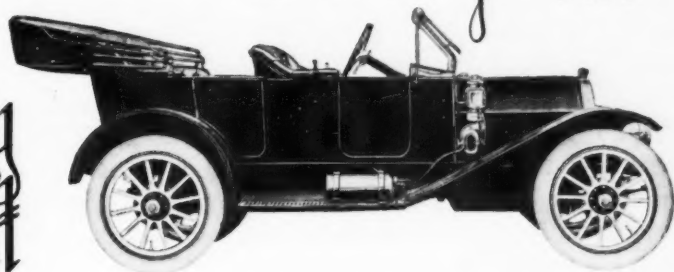
By Churchill Williams

THE number of those who lay up their cars for the winter is now few. The automobile has become an all-year-around vehicle. If there is not so much pleasure to be had from it in the winter as in the summer, enough remains to make its use well worth while. The man who puts away his car with the first winter storm is almost sure to regret it, again and again, on those sunshiny days when there is sufficient cold to keep the road-bed firm, the travel of iron-tired vehicles has perhaps worn down the worst of the ruts, if any, and the bracing air invites a run into the country. Moreover, except for those who can afford to spend for almost whatever they fancy, the use of the car during the winter does not imply the possession of a limousine body. The perfect protection from weather that such a body alone affords

is, of course, justification for its adoption, if within one's reach, and its employment is steadily increasing. But the limousine is expensive, not only because of its greater first cost, but also because of the heavier charges for upkeep entailed by its weight and the essential accompaniment of a chauffeur. The man who drives and probably also looks after the general welfare and cleaning of his car must, therefore, be content with a regular touring or roadster body. During cold or inclement weather he must rely for the protection of his passengers and himself upon the folding water-proof top and the windshield with which most cars are regularly equipped, and upon the front doors now attached to many of them. Furthermore, it should be said right here that, if proper attention be given to the selection of a durable

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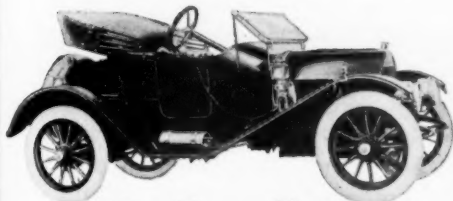
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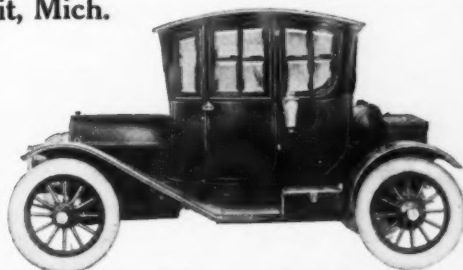
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The Car in Cold Weather

material for the top, to its careful fitting, preferably with side curtains that meet the edges of the windshield for their entire height, and to the choice of a windshield that allows of its use in wet or misty weather without interference with the vision of the driver—if these precautions be taken, anyone in ordinary health can be thoroughly comfortable in such a car, provided further he or she dresses himself appropriately.

It is, however, upon the efficiency of the car itself that comfort and pleasure ultimately depend. To secure this in winter with its rapid, and, in some latitudes, severe changes of temperature and atmosphere, the mechanism of the car as a whole, and that of the motor in particular must receive rather more attention than is needed in summer. Freezing radiators, pumps, piping, and water jackets have almost ceased to be bugaboos, except where the thermometer makes quick tumbles well below the zero mark. Denatured alcohol mixed with the cooling water will effectively prevent freezing within probable limits, and it will do no harm to the metal parts or rubber joints. The proportion of alcohol to water required by the lowest temperature likely to be encountered can be speedily and accurately determined by floating in the mixture an inexpensive little instrument to be obtained at equipment stores and popularly known as a freezometer. It should be remembered, however, that alcohol under the heat generated by the engine, evaporates somewhat rapidly, and it is necessary therefore to make tests of the mixture in the radiator, at more or less frequent intervals, adding alcohol as re-

quired, to bring up the solution to the proper strength. Less effectively regulated because a single adjustment can not be made to provide fully against the influence of a wide range of changes, is the functioning of the motor. The consistency of lubricating oil and the composition of the gas mixture will vary with heat or cold, and, while the phenomena thereby produced are fairly familiar to most motorists, as are also the means employed to correct these, a few suggestions along general lines may not be out of place.

Perhaps the most common difficulty experienced in cold weather is in starting the engine, unless the car has been kept in a reasonably warm place. Low temperatures interfere with vaporization, and, under such circumstances, the most that can be done, for the purpose of starting, is to see that the cylinders receive an over-rich charge. Some carburetor air-intakes are now supplied with a shut-off valve, which, if closed, puts an extra strong suction upon the gasoline nozzle. Where this valve is lacking, and priming the carburetor does not achieve the purpose, the auxiliary air valve should be held tight by screwing down its adjustment, or by covering it or the fixed air opening with a cloth large enough not to be sucked in, this being removed, of course, as soon as the engine has warmed up. If, however, the motor still refuses to start, a few drops of gasoline injected through each of the relief cocks, will usually do the trick. In specially obstinate cases I have got immediate results by draining the radiator and refilling with boiling water. A cloth wrung out in boiling water and wrapped around the

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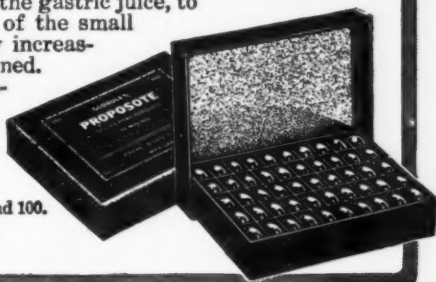
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The Car in Cold Weather

inlet pipe will sometimes prove effective.

Owing to the fact that, in cold weather, the engine has a tendency, unless assisted as above, to draw in a much diluted or badly mixed charge, which burns too slowly, carburetor fires, from a flare-back down the induction pipe, are somewhat frequent. These carburetor fires are alarming, and unless speedily checked, may do serious damage to the car, and possibly to the building in which it stands. In any event, not a moment should be lost in making an end to them. The gasoline supply should be promptly cut off at the tank, and every endeavor made to get the engine going fast. If that can be accomplished, the fire will be drawn up through the induction pipe and the gasoline supply quickly exhausted. Should it not be possible to start the engine, a small cupful of carbon tetrachloride, or the same amount of baking soda thrown on the flames will quickly smother them. The use of sand for extinguishing purposes, I discourage, as, even if effective, it generally involves dismemberment and thorough cleaning of all the working parts of the motor upon which it falls. In any event, *do not* attempt to put out such a fire with water. Water will not extinguish even a small conflagration of this nature; on the other hand, it is likely to float the flaming gasoline and so spread its attack.

But, even after having warmed up, the motor of the average car will not give the best results in very cold weather unless special provision be made to prevent the too-rapid dissipation of its heat. Most water systems are designed to have ample capacity

for cooling the engine during extremely hot weather, with the result that the cooling is overdone under the influence of low external temperatures. This fault may be easily overcome in several ways. A sheet of heavy asbestos paper or of thin metal may be fastened against the outside of the radiator, covering one-half or more of its surface, and thereby neutralizing radiation to a considerable extent. Also the fan belt may be loosened so as to allow of a slip that cuts down the draught, or in extreme cases, be removed entirely, though this last seems to me to be decidedly risky. Occasionally a blanket or quilted covering is fitted over the whole hood, also with the idea of reducing radiation. Any one of these expedients, together with the application to the carburetor of a pipe to convey hot air from the neighborhood of the exhaust line, or, if permitted by the construction of the carburetor, of pipes to maintain a circulation of hot water or hot air around the vaporizing chamber, will generally result, even during the coldest spells, in a motor efficiency not so far below that obtained in summer. But in some instances, even with all helps to the production of a homogeneous gas mixture, it may be found wise to maintain a slightly greater tension upon the spring of the supplementary air-inlet valve, with the idea of increasing the draw upon the nozzle.

The influence of low temperatures upon all lubricating oils and compounds is to thicken them. Thereby their flow is made more sluggish and the feed slower. The very decided improvement, within the past few years, in the production of oils in-

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The Car in Cold Weather

tended for use in internal-explosion motors has reduced to a minimum the troubles formerly experienced from this source, but even yet it behooves the wise motorist to watch his lubricating system rather closely during cold weather. In motors in which the lubricating system is self-contained—that is, having the oil supply in the base from which it is fed into channels into which the connecting-rod ends dip and from which they in turn splash the oil onto the walls of the cylinders—the oil has small chance to receive warmth from the engine until it has all been distributed by the pump and returned to the reservoir. Under these circumstances, lubrication, for at least a short time after starting the engine, may not be all that it should be, and while I have never personally known any serious injury to result to crankshaft bearings or cylinder walls, it is well to remember the conditions existing, and not push the motor to its limit until it seems certain that thorough circulation of the oil has been established. The use of a free-running oil, however, will practically eliminate danger of this sort, and, at the worst, inspection of the oil drip at the gauge, whether this be on the dash or elsewhere, should warn the operator of any failure in plenty of time.

In the case of the transmission and differential boxes, it has been my experience that the best results are obtained from employing a somewhat lighter-bodied oil or grease in cold weather than in summer, particularly as, in most cars, it is upon the splash from the churning gears that the shaft bearings in these places must depend for lubrication. In all grease cups,

such as those at spring suspensions, at steering-rod joints, and the like, that are exposed directly and continuously to the cold, it is certainly better to substitute a soft grease for the heavy compound that is equally effective and far more cleanly in warm weather. The only exceptions to this rule are those grease cups that are under the hood or those upon which the heat from the motor flows back.

Paint, varnish and upholstery are likely to suffer more in winter than in summer, other things being equal. Cold tends to make them brittle and more susceptible to cracking and peeling. In cold weather, too, the washing of the car is apt to be done hastily, mud being allowed to accumulate and wet surfaces not being thoroughly dried. This means, aside from the slovenly appearance it lends the car, that the finely glazed surfaces soon lose their gloss, and are the more easily attacked by the acid that is in all road dirt. Leather likewise stiffens in cold weather, and is therefore inclined to crack wherever a fold occurs. This is more particularly so in leather that has been in use several seasons and has lost some of its elasticity. In cleaning the car in winter every care should be taken thoroughly to soften caked mud with the stream from the hose before attempting to remove it with the sponge, and every inch of painted surface should be dried with soft cloths and a chamois. Finally, varnished surfaces, particularly those of the hood and dash, as well as the leather upholstery, should be lightly gone over occasionally with a flannel moistened with a good furniture polish. This coating should be rubbed off with a dry clean flannel.



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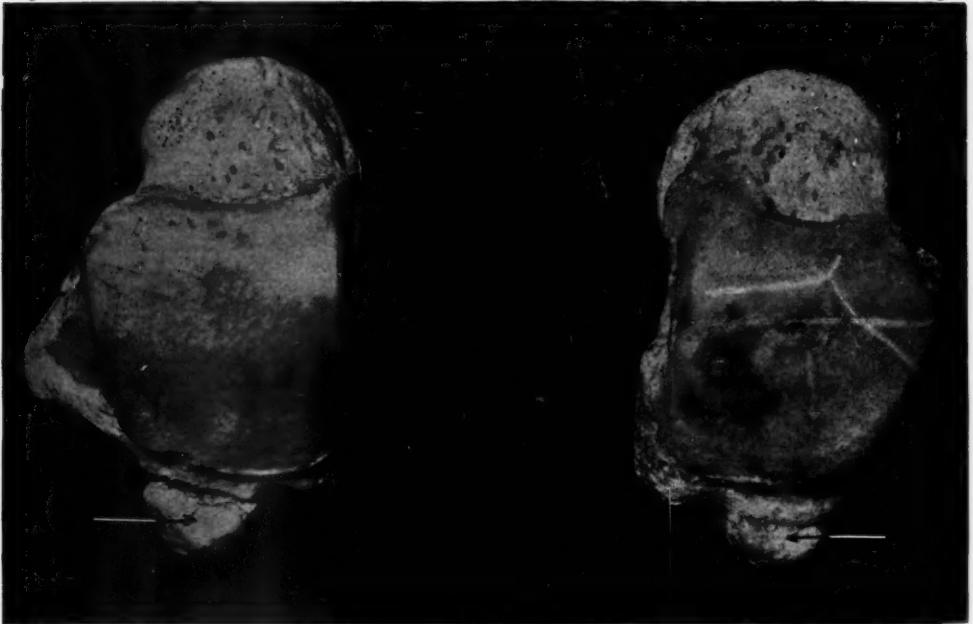
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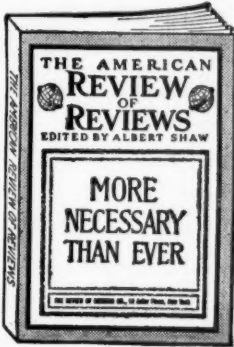
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Success (or any Class 17).....	1.00	for the three
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Lippincott's Magazine.....	\$3.00	\$4.00
Sunset (or any Class 23).....	1.50	for the three
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Harper's Bazar (or any Class 20).....	1.25	for the three
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Lippincott's Magazine.....	\$3.00	\$5.00
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Lippincott's Magazine.....	\$3.00	\$4.70
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Lippincott's Magazine.....	\$3.00	\$5.40
Field and Stream (or McClure's).....	1.50	for the three
Outing.....	3.00	

Lippincott's Magazine.....	\$3.00	\$5.65
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World To-Day.....	3.00	
Lippincott's Magazine.....	\$3.00	\$5.25
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Lippincott's Magazine.....	\$3.00	\$5.40
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Lippincott's Magazine.....	\$3.00	\$7.00
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FOR CLASSIFIED LIST SEE PAGE 13

Our Best Offer This Year: Ladies' World - 1 yr. - .50 } All
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Lippincott's - - - -	3.00	
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Good Housekeeping - -	1.50	
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Cosmopolitan - - - -	\$1.50	Our Price only \$3.90 for Three
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(or McClure's)		
Lippincott's - - - -	3.00	
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Good Housekeeping - -	\$1.50	Our Price only \$3.90 for Three
Woman's Home Comp'n	1.50	
Lippincott's - - - -	3.00	
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McClure's - - \$1.50	Both
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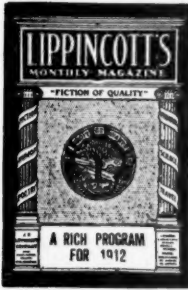
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Cosmopolitan - 1.50	\$2.15

McClure's - - \$1.50	Both
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McClure's - - \$1.50	Both
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Companion	6.55
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